# Why is the Earth known as the blue planet?

OCEANS AND SEAS

1. Because it is surrounded by clouds
2. Because, seen from space, the seas and oceans form a great blue expanse

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# Earth

**Did you know that 70 percent of Earth is covered with water? It is all that water that makes our planet look like "a big blue marble" when seen from space.**

## 2 Earth is known as the blue planet because, seen from space, the seas and oceans form a great blue expanse.

Photo Nasa-Science / Explorer

The seas and oceans of Earth cover 70 percent of its surface, making it appear extremely blue when viewed from space.

Only 30 percent of Earth is covered with land. There's an amazing 843,200 million square miles (1,360 million sq. km) of it covered with water. When people first saw photos of our planet, taken from a space satellite, they said it resembled a big blue marble . . . do you agree?

With all this water, you'd think there would always be plenty to drink, right? Wrong. About 95 percent of that water is salty, and another 2.2 percent is locked in glaciers. That leaves about 2.3 percent fresh water, in lakes, rivers, marshes, creeks, and underground. But lots of that fresh water is unusable due to pollution, so we're able to use less than one-half a percent of the water on our "blue planet!"

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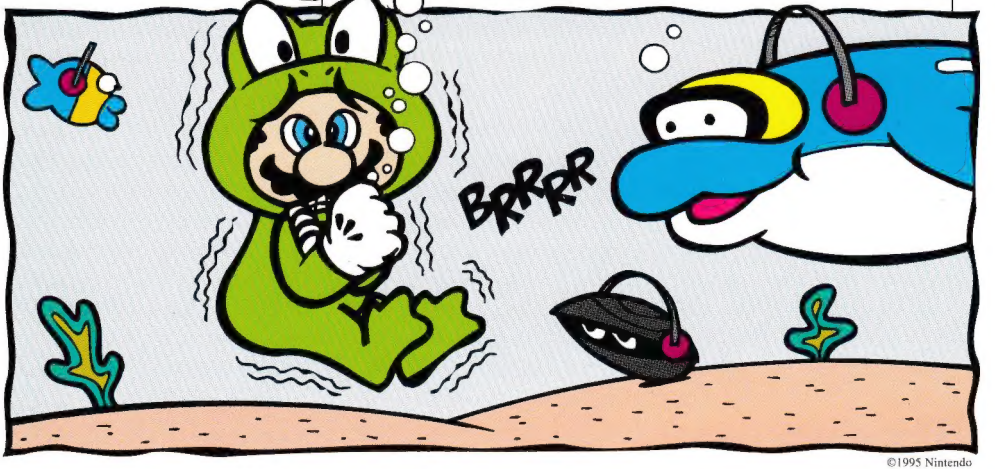
# What's an abyss?

OCEANS AND SEAS

1. Fish from the ocean depths
2. Respiratory problems caused by diving into the water too fast
3. The ocean bottom that's more than 6,560 ft (2,000 m) deep

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# Abyss

**People once thought the ocean floor was flat. It isn't. Deep valleys, wide grasslands, and towering mountains at the bottom of the sea form an abyss—a dark world that the sun can't enter.**

A strange environment greets oceanographers who study the bottom of the ocean from the confines of small submarines. On the ocean floor is a mysterious landscape of vast mountain chains, widespread prairies, and undersea volcanic cones. There's also a series of steep valleys and pits that plunge more than 36,080 ft (11,000 m) down the abyss.

**3** **An abyss is the ocean bottom at a depth of more than 6,560 ft (2,000 m).**

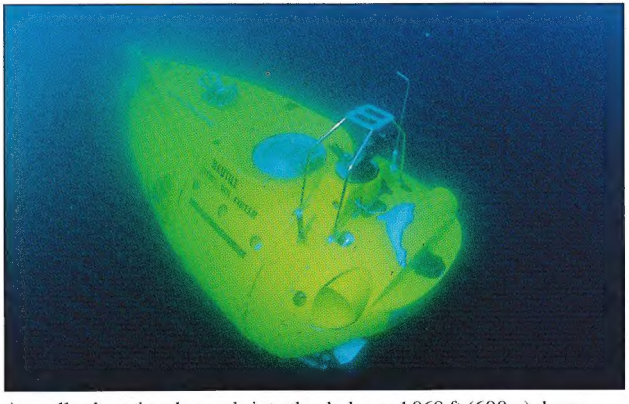

Photo © Gladu / Explorer

A small submarine descends into the darkness 1,968 ft (600m) down.

**Life Down Under**

To a depth of about 500 ft (152 m), the sun penetrates the ocean water and green plants grow. From 500-1,500 ft (152-457 m), there's only a grayish light and some plant life. But below 1,500 ft (457 m), even seaweed can't grow and the only light comes from the glowing luminous parts of some underwater creatures! In some places the sea floor is below the freezing point—32 degrees Fahrenheit (0 degrees Celsius). The water doesn't freeze, however, because of it's salt content.

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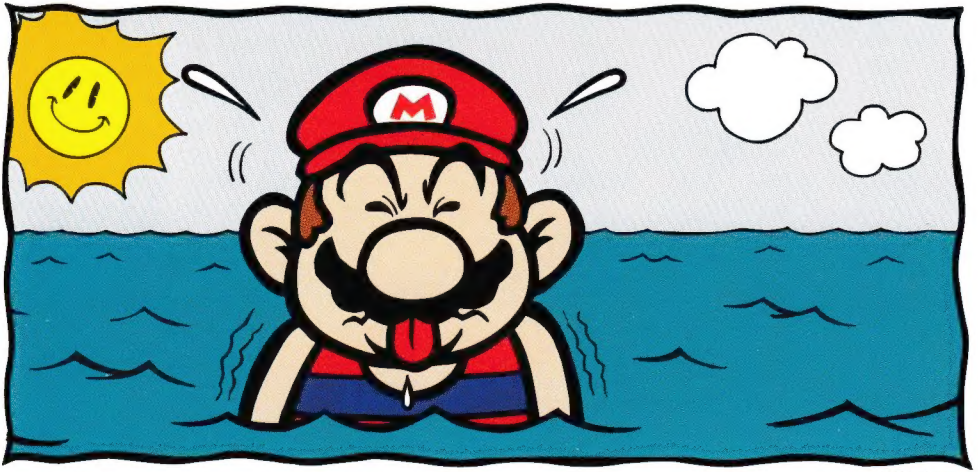
# Which is the saltiest sea?

OCEANS AND SEAS

1. The Caspian Sea
2. The Mediterranean Sea
3. The Dead Sea



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## Dead Sea

**The Dead Sea, on the border between Jordan and Israel, is so salty that people float in the water effortlessly. In fact, it's practically impossible to dive into the salty water because your body pops right back up to the surface!**

# 3 The Dead Sea is saltiest sea.

Photo © Richard/Explorer

The Dead Sea has no spillway, its water disappears by evaporation only. Evaporation leaves the salt behind as crystal hills floating on the water's surface.

This saltiness has eliminated life in and around the sea. Average sea water is 3.5 percent salt. Water in the Dead Sea is 28 percent salt on the surface and 32 percent salt at its deepest parts. Its waters are so saturated with mineral salts that columns of salt often appear on its surface.

Where does the salt come from? The Dead Sea is a closed sea. Millions of years ago, the Mediterranean covered the region. When, over a period of years the Mediterranean dried up, its salt was left behind in great quantities as hills of salt. Now rivers that feed the Dead Sea bring more salt picked up from the neighboring hills.

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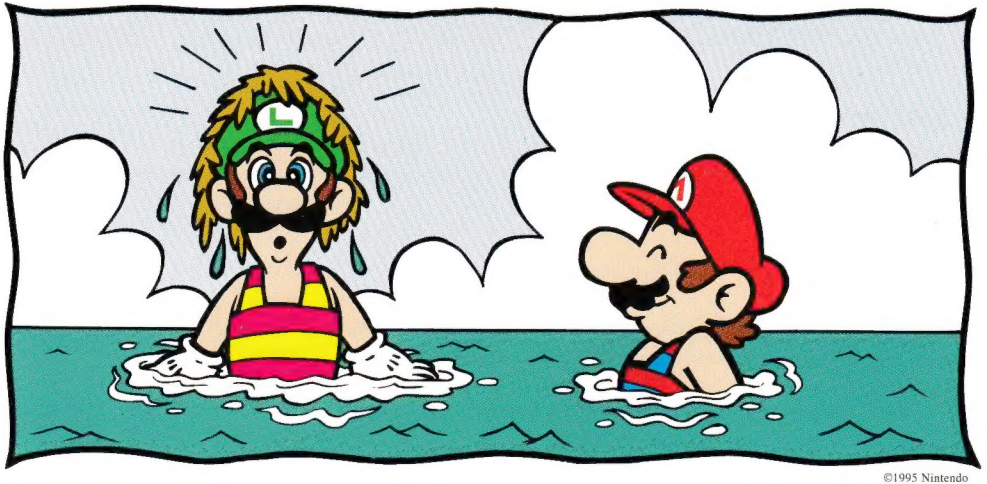
# What is seaweed?

OCEANS AND SEAS

1. The name of the first submarine
2. A fish
3. Marine algae



©1995 Nintendo

# Seaweed

**Seaweed is the name given to marine plants or algae. It's used to make fertilizer, food for animals and people, medicines, and other products.**

## 3 Seaweed is marine algae.

Photo © Roy / Explorer

In the Brittany region of France, people gather seaweed the old-fashioned way—with pitchforks and horse-drawn wagons.

There are 7,000 species of seaweed, including the giant kelp of California that grows 200 feet (61 m) long. The most common color is brown, but there's also red, blue, green, and even purple seaweed. Most seaweed is rooted mostly along the coasts to rocks located between high and low tide areas and in shallow waters. Like all plants, seaweed uses the sun's energy to convert carbon dioxide, chemical nutrients and water into "food." This is called photosynthesis.

### Who Eats Seaweed?

Believe it or not, you've probably eaten seaweed. It's used to make ice cream thick and delicious, and it's often served as a vegetable in Asian cooking. Used as a fertilizer, seaweed stimulates the growth of plants and gives them better resistance to cold weather and disease. Some seaweed contains large amounts of iodine and potash, compounds used in making medicines and cosmetics. Seaweed has also been used to stuff furniture, make paper, and even make rope.

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# Which sea has the least salt content?

OCEANS AND SEAS

1 Dead Sea

2 Baltic Sea

3 Mediterranean Sea

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# Sea Salinity

**Sea water is 85 percent chloride and sodium, the elements that form salt. Yet some seas are saltier than others.**

## 2 The Baltic Sea has less salt content than other seas.

Photo © L. Jahan / Explorer

The ocean salt that nature leaves behind during the water cycle, like that shown in these salt marshes, is an important resource. We all need salt!

The salinity, or saltiness, of ocean water varies depending on local conditions. For example, the Baltic Sea, in northern Europe, receives most of its water from freshwater sources, such as rivers and melting snow, so it has low salinity. In equatorial and tropical seas where rain is plentiful, salinity is average. The Dead Sea, bordering Israel and Jordan, has high salinity because it's in a hot region that receives little rain and where fresh water evaporates quickly.

**From Salty to Fresh Water**

Some countries with insufficient freshwater supplies have desalinization plants that turn salty sea water into drinkable fresh water. They use a process that mimics nature's own water cycle, by producing freshwater rain from water vapor that was collected from salty and dirty water. In the desalinization plant, salty water is pumped in from the sea and heated to increase the evaporation of its freshwater content. Then the vapor is cooled so it condenses into fresh water.

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# Which are dangerous ocean waves?

OCEANS AND SEAS

1. Tsunamis
2. Storm surges
3. Both of the above

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# Waves

**Wind causes most ocean waves, from small ripples to dangerous hurricane waves more than 100 feet (30 m) high. But some waves are caused by underground activity.**

## 3 Both tsunamis and storm surges are dangerous ocean waves.

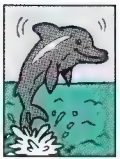

Photo © P. Roy / Explorer

As waves approach the shoreline, they may gently break and lap a sandy beach or thunder ashore as huge breakers.

As wind blows at sea, waves grow in size, then break. Waves that break on the water are called whitecaps. Sometimes storms send surges of waves that break on shore at high tide and flood nearby land areas.

**Terrible Tsunamis**

Some waves result from earthquakes that suddenly move the ocean floor. Scientists call these waves tsunamis. They can barely be seen on the ocean's surface—they measure only about 1 inch (2.5 cm) high. But they may travel 450-500 miles (700-800 km) per hour. As tsunamis approach land they slow down and may rise to gigantic heights, hitting the shore as huge breakers 100 feet (30 m) above normal sea level. They can cause great damage—some have destroyed entire towns. Most tsunamis strike along the Pacific Ocean coast. Luckily, scientists can predict how fast a tsunami will travel and are able to warn people in its path.

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# What causes ocean tides?

OCEANS AND SEAS

1. Evaporation of water vapor from the sea
2. Gravity or attraction from the moon
3. Winds in the upper atmosphere

©1995 Nintendo

# Tides

**Tides are the rise and fall of ocean water. High and low tides occur twice a day. They are caused mainly by the moon's gravitational pull on Earth.**

## 2 Tides are caused by gravitational pull from the moon.

Photo © C. Delu / Explorer

The shallow waters of France's Mont-Saint-Michel Bay recede so far at low tide that the famous fortified rock is left high and dry!

As Earth rotates on its axis, the moon revolves slowly around Earth. Wherever the moon is directly above Earth, the moon's gravity pulls the water directly below it slightly away from the solid part of Earth. This creates a high tide. At the same time, the moon's gravity pulls Earth itself slightly away from the water on the opposite side of Earth. So high tide occurs on this opposite side, too. About six hours later, both areas will have low tide. As Earth turns, high and low tides occur twice a day in the time between two rising moons—24 hours and 50 minutes.

### The Sun's Influence

Sometimes the sun influences tides, too. When the sun's gravity pulls along with the moon's, exceptionally high tides, called spring tides, result. When the sun's gravity pulls against the moon's, exceptionally low, or neap tides occur.

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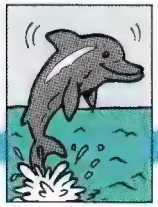
# From which shellfish do we get pearls?



OCEANS AND SEAS

1 Clams

2 Abalone

3 Oysters

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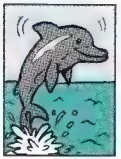
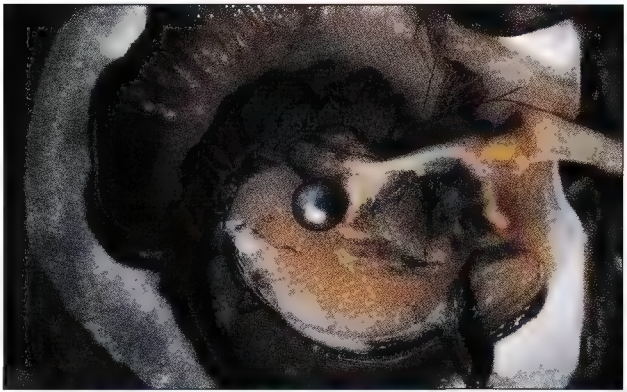
# 3 We get pearls from oysters.



## Pearls

**Pearls are soft deposits of calcium carbonate that form around a grain of sand or other foreign body that enters an oyster's shell. Forming beautiful pearls is an oyster's reaction to being bothered—its way of scratching an itch!**



© P Plisson, Explorer

A pearl inside an oyster shell. Before the development of less expensive cultured pearls, a string of pearls was a sign of great wealth.

Oysters and other mollusks secrete a substance called nacre that forms a smooth, shiny lining inside their shells. If even a grain of sand gets into an oyster's shell, it irritates the oyster. To soothe the irritation, the oyster secretes layers of nacre over the sand, creating a pearl. Most pearls are round and white, but some are pear or teardrop shapes, and can be black, pink, orange, or gold.

### Cultured Pearls

In the early 1900s, Kokichi Mikimoto of Japan found a way to force oysters to create pearls on demand. These are called cultured pearls. Instead of waiting for a grain of sand to accidently enter the shell, a larger core is inserted by hand. The oyster coats this core with only a few layers of nacre, so cultured pearls are less expensive genuine ones.

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# Is sea level always the same?

OCEANS AND SEAS

1 Yes, since the beginning of time.

2 No, it has changed in the past 10,000 years.

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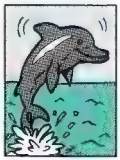
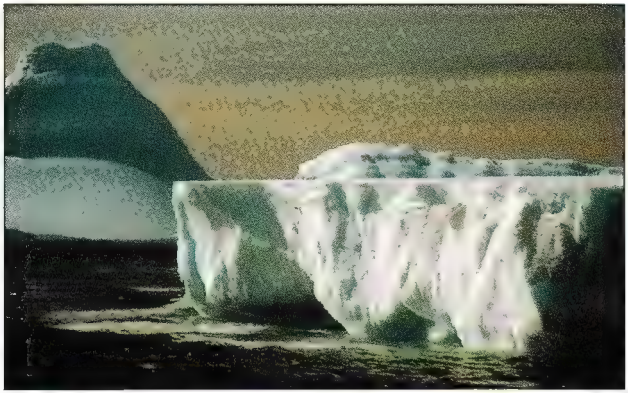
## Sea Level

**Sea level is the level of the ocean's surface. It's used as a constant point when calculating land elevation—above sea level—or ocean depth—from the water's surface to the ocean floor.**

## 2 Sea level has changed many times in the past 10,000 years.





© Tormo / Sipa Press

It's estimated that the seas would rise about 200 feet (60 m) if the Greenland and Antarctica ice caps should suddenly melt.

When glaciers covered the continents, the oceans lost a large part of their water supply. The sea level dropped, exposing some parts of seacoasts that, until then, had been under water.

**Refilling the Seas**

Later, when the glaciers melted, the sea level rose, submerging the seacoasts again. In total, the level of the sea has varied from +328 feet (+100 m) to -328 feet (-100 m) in relation to its present level. Since the Ice Age, approximately 10,000 years ago, our coastlines have shown a rise in sea level of about 10 feet (3 m). The depth of the whole ocean averages 12,240 feet (3,730 m), but the deepest point, in the Marianas Trench, is 36,198 feet (11,040 m) deep.

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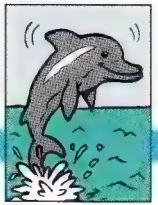
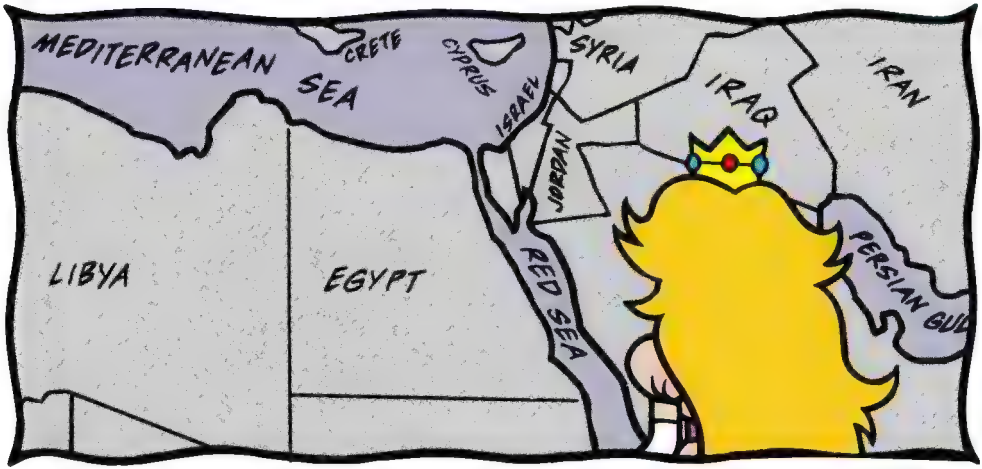
# Which canal connects the Mediterranean and Red Seas?



OCEANS AND SEAS

1. The Panama Canal
2. The Erie Canal
3. The Suez Canal

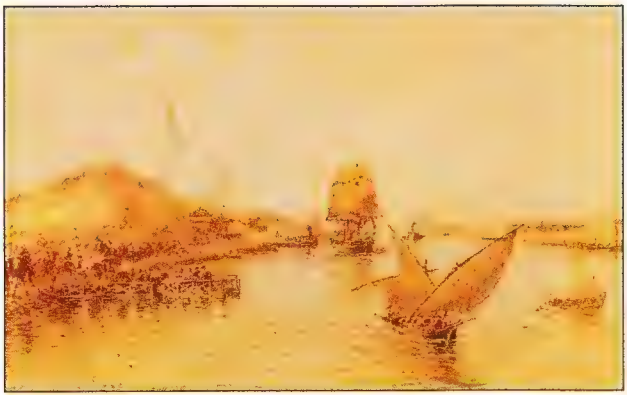



©1995 Nintendo

## Suez Canal

**From Port Said, an Egyptian harbor on the Mediterranean Sea, the Suez Canal runs for 100 miles (160 km) south to the Red Sea. The canal, opened in 1869, created the shortest sea route from Europe to the Indian Ocean, by way of the Red Sea.**

# 3 The Suez Canal connects the Mediterranean and Red Seas.



© ERL / Sipa Icono

A view of the Suez canal around 1850.

Before the Suez Canal was built, ships carrying goods between Europe and Asia had to sail around the continent of Africa to reach their destinations. The canal cut the length of the trip by 40 percent.

**Canal Commerce**

By the end of the 19th century, the Suez Canal had already become one of the world's most frequently traveled waterways. Since each ship paid a fee to use the canal, it was a real money-maker for the country controlling it. England owned it from 1875 until 1956, when it became the property of Egypt. Blocked by Egypt during the Arab-Israeli War of 1967, the canal was not reopened to traffic until 1975. Between 1976 and 1980, it was widened and deepened to permit passage of oil supertankers.

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# Which is the world's largest ocean?

OCEANS AND SEAS

1. Indian Ocean
2. Atlantic Ocean
3. Pacific Ocean

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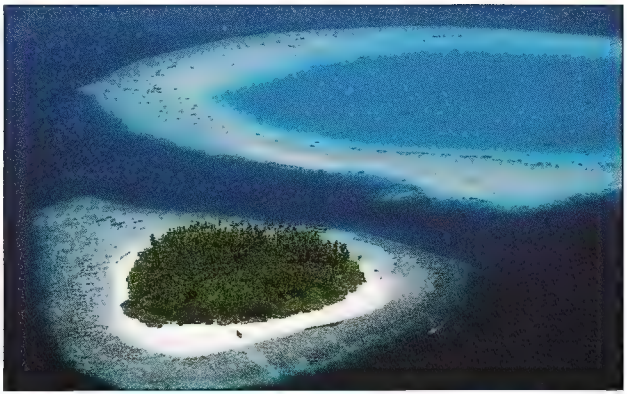
# Pacific Ocean

**The Pacific Ocean covers about one-third of Earth's surface, is bigger than all of Earth's land surfaces combined, and covers the deepest spots on Earth's surface.**

## 3 The Pacific Ocean is the world's largest.



© E. Valentin / Hoa-Qui

Many Pacific islands are the tops of volcano cones or coral reefs, built on underwater mountain peaks. Atolls, like the one shown, are circular coral reefs that enclose lagoons.

The Pacific Ocean covers 64,170,000 square miles (166,201,600 square km), twice the size of the Atlantic Ocean. It includes Earth's deepest spot, in the Marianas Trench near Guam, 36,210 feet (11,036 m) deep.

**Peaceful Pacific?**

The ocean was named by Portuguese explorer Ferdinand Magellan in 1520. He named it Pacific, which means peaceful, because for weeks his ship's sails were pushed by gentle winds across the immense ocean's warm, quiet waters. But the Pacific isn't always peaceful. It can spawn a typhoon, one of the most destructive storms on Earth. Or its underground volcanoes can launch a tsunami, a tidal wave so high it may roll completely over islands in its path. But the volcanoes under the Pacific can also do good things, like building beautiful tropical islands and coral reefs.

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# What is a snorkel?

OCEANS AND SEAS

1. A baby donkey
2. A prehistoric bird
3. A breathing tube

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# Snorkel

**Skin divers hold their breath underwater. No equipment is needed, but most divers use short breathing tubes, or snorkels, while they float or swim face down on the water's surface. To go under, they take a deep breath and dive.**

## 3 A snorkel is a breathing tube used by divers.

© Cinello / Sipa Press

The snorkel allows the diver to slowly let out his or her breath underwater. But to take a breath, the diver must surface.

Along with their snorkels, skin divers usually wear face masks and swim fins. Each diver also wears a buoyancy compensator—a belt with weights that helps a diver stay submerged instead of floating upward.

**Down...and Up**

Since skin divers must return to the surface for air, they can't dive too deeply. Most dive 30-40 feet (9-12 m), and return to the surface in less than a minute. Some divers can dive 100 feet (30 m) and stay under about two minutes.

**History of Skin Diving**

In about 100 A.D., people used hollow-reed snorkels when diving for food and sponges. By 1300, divers in Persia used goggles made from tortoise shells. Today snorkels are made of rubber, and masks and goggles are rubber with plastic or glass.

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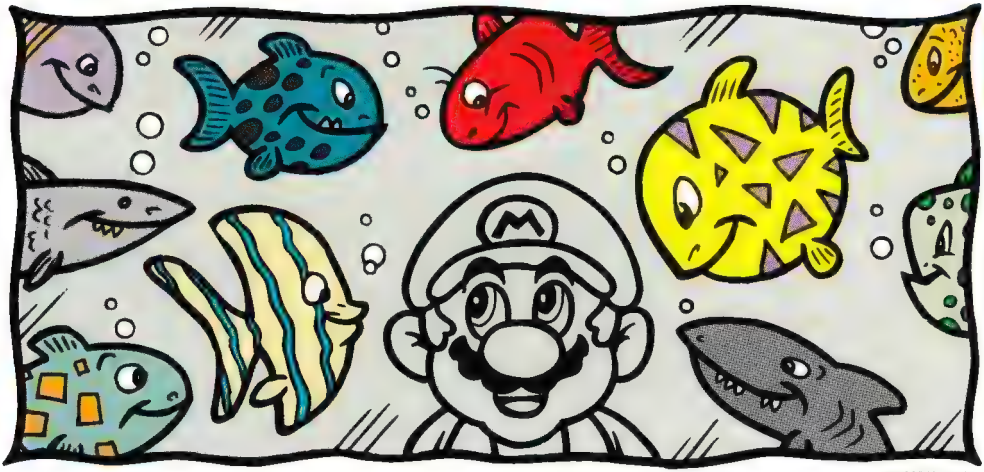
# How many species of fish exist?

OCEANS AND SEAS

1. 30,000
2. 46,000
3. 52,000



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# Fish

**Fish are perfectly adapted for life in water. Today's 30,000 species developed from fish that lived during the Devonian period—345 to 395 million years ago—a time known as the Age of Fishes.**

**1** **There are 30,000 recorded species of fish.**

© G. Lacz / Sunset

A fish's eyes are perfectly designed for its environment: the large lens can bend and focus light rays coming through the water.

Scientists divide fish into two groups. Bony fish, like bass, minnows, trout, and tuna, have complete bony skeletons. Cartilaginous fish, like sharks, skates, and rays, have bony skulls and vertebrae, but the rest of their skeletons are made entirely of cartilage. Cartilage is lighter than bone, so these predators move faster in water than bony fish. The stiff fin of the shark also helps it maneuver more easily toward its prey.

**Bony Fish**

Bony fish make up the largest part of today's living species. Their bodies are covered with scales, their gills are covered with a single flap, and their movement through the water is controlled by movable fins. Many bony fish have a swim bladder used to adjust buoyancy. Most lay eggs.

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# What is aquaculture?

OCEANS AND SEAS

1. The raising of silkworms
2. The raising of marine animals and plants for food
3. The raising of green watercress

©1995 Nintendo

# Aquaculture

**Aquaculturists raise fish, crustaceans, shellfish, and seaweed under controlled conditions. Their primary purpose is to produce food for people.**

## 2 Aquaculture is the controlled raising of marine animals and plants for food.

© Novost / Spa Press

Aquaculturists assist in the raising of salmon.

Aquaculture, or "fish farming," is done in tanks or in natural ponds of water. Crops are raised in nets or cages, or attached to rafts. Aquaculturists careful control the animals' and plants' environment, nutrition, life cycle, and breeding, in hopes of improving the quality of their products. About 10 percent of all fish consumed worldwide are "farmed," especially salmon, trout, eel, oysters, and mussels. Farmers in Asia raise seaweed for food and for important ingredients like agar and carrageenin, used as thickeners or gelling agents in drugs, foods, and other products.

### Ancient Profession

Aquaculture was practiced in China over 3500 years ago. Today, China is still the world's leading producer of freshwater fish. In the U.S., aquaculture tripled in the 1980s. Worldwide, fish and seaweed farming has continually expanded as people search for ways to feed the world's rapidly growing population.

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# What is the average length of time between high and low tides?

OCEANS AND SEAS

1. About 12 hours
2. About 11 hours and 40 minutes
3. About 6 hours and 12 minutes

©1995 Nintendo

# High Tides

**Tides are the rise and fall of ocean water. High tides occur twice a day, once every 12 hours, 24 minutes, and 30 seconds. Low tide also occurs twice, about 6 hours and 12 minutes later.**

**3 The average length of time between high and low tides is about 6 hours and 12 minutes.**

© M. Brigaud / Sipa Press

This tidal-driven factory in Brittany, a province in France, depends on the timing of the tides to get maximum energy efficiency.

Tides are caused mainly by the moon's gravitational pull on Earth. The moon's gravity pulls the water directly below it slightly away from the solid part of Earth creating a high tide there. At the same time, the moon's gravity pulls Earth itself slightly away from the water on the opposite side of Earth, causing a high tide on this opposite side too. About 6 hours and 12 minutes later, both areas will have low tide.

**Humans and Tides**

Tides occur all over the world, but not all at the same time. The exact time depends on the location, but even in harbors, tides don't occur at the same time every day. Some occupations rely on knowledge of the tides. Ship captains need to know because they usually head out to sea on the high tide. And in some places, engineers have harnessed the powerful surge of water at high tides to provide energy to factories.

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# What is the name of the land and sea at the North Pole?

OCEANS AND SEAS

1. Antarctic
2. New Jersey
3. The Arctic

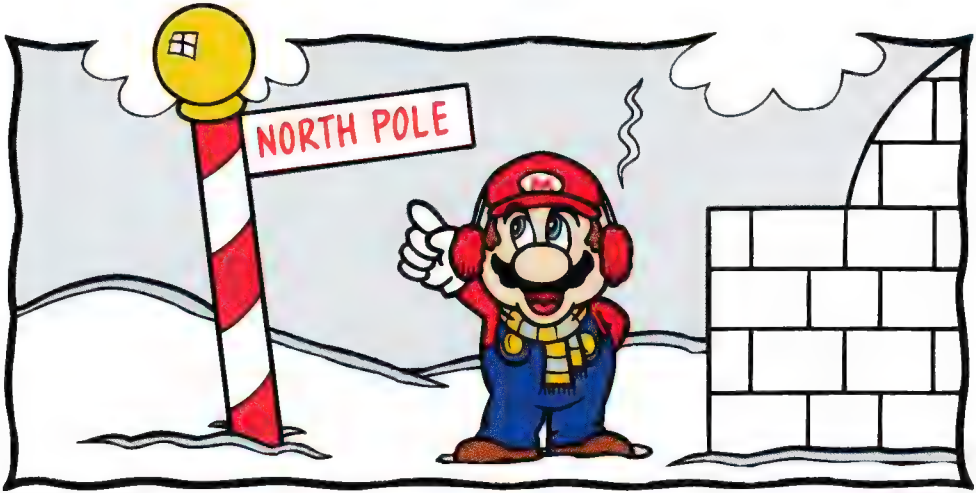


Illustration Gary Fields

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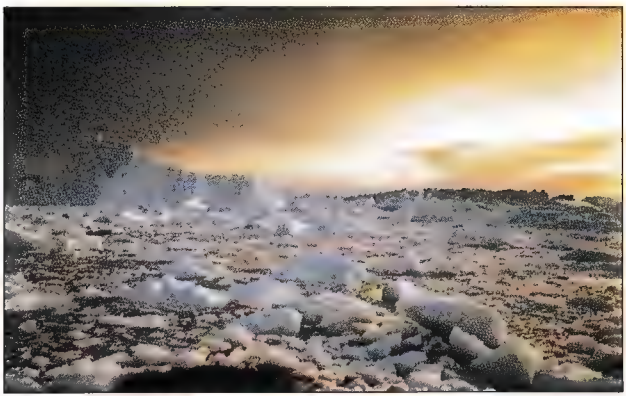
## The Arctic

**The Arctic Circle is the land and sea at the top of the world, with the North Pole at its center. It covers eight million square miles (20.8 million sq km).**

# 3 The land and sea at the North Pole is called the Arctic.



© Ken Griffiths / Tony Stone Images

Much of the Arctic Ocean is always ice covered, and the ice is in continual motion.

There is a zone in the Arctic Circle where every year, during one 24-hour period, the sun does not set and one period when it does not rise. Unlike Antarctica, the continent at the South Pole, which is surrounded by water, the Arctic is an ocean mostly surrounded by land.

**Maritime Passage**

After being considered unnavigable for centuries, the Arctic Ocean is one of the most important waterways in the world today. Crossing the Arctic Ocean, by boat or by plane, is the quickest route from the U.S. to Russia. The Siberian and the Canadian channels join the Atlantic and the Pacific oceans. For a long time this passage was only accessible to boats during the summer but with the advent of ice-breakers—boats built to cut through thick layers of ice—the waters can be traveled year-round.

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# What is a popular type of fishing boat?

OCEANS AND SEAS

1. A trailer
2. A trawler
3. A kayak



Illustration Gary Fields

©1995 Nintendo

# Trawlers

**Trawlers are commercial fishing boats that catch fish with a cone-shaped net called a trawl. They can be seen in all the world's oceans and seas.**

## 2 A trawler is a popular type of fishing boat.

© Len Sirman

Some trawlers function like real water-bound factories, carrying out tasks from catching to processing the fish.

A trawler is any boat that uses a trawl net for fishing. Cone-shaped trawl nets catch fish when dragged through the water. Trawlers come in many shapes and sizes. Traditional small boats include the double-ended Naples trawler and the Chinese trawling junk. During World War II trawlers were converted to warships because they were so well built. Many of the bigger trawlers today are operated by the Japanese and Russians.

**High-Tech Trawlers**

Large commercial trawlers are equipped with sophisticated electronic gear that makes it possible to drag huge trawls anywhere from 200 to 300 feet (60-90 m) long. These machines can haul tons of fish on board with minimal manpower. Ultrasound fish-finders send high frequency sound waves under the water to help the fishermen locate large schools of fish.

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# What causes water waves?

OCEANS AND SEAS

1. Swimming
2. Electricity
3. Disturbance

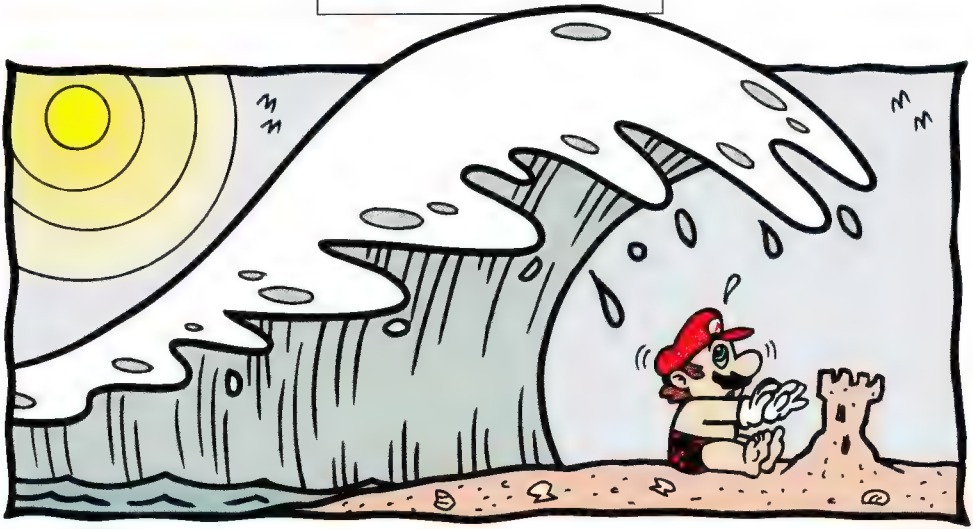


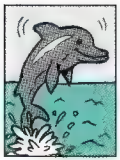
Illustration Gary Fields

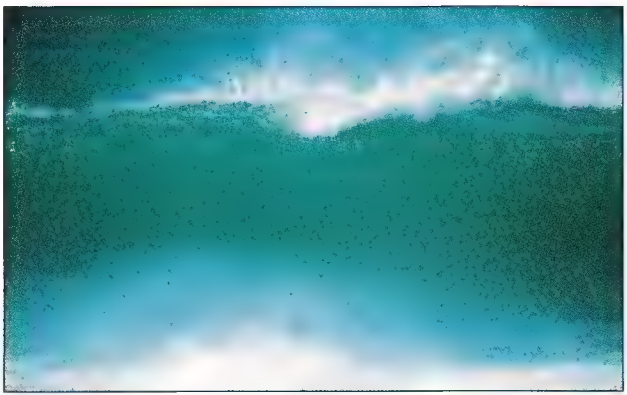
©1996 Nintendo

# Water Waves

**Waves, like those in the ocean, occur when the interface between the water and the air is disturbed by the wind, or some other force.**

## 3 Waves are caused by external disturbance, such as wind.





© E. Valentin / Hoaqui

Tsunamis, resulting from underwater earthquakes, can reach heights of 90 feet (30 m).

A wave is an example of a form of energy being moved from one place to another. Most ocean waves are caused by the wind. Most of the wave's movement is water particles moving up and down, not forward—similar to the cracking of a whip.

When a wave breaks on the beach, the energy that formed it is lost and the ocean water returns to its original state.

### Big and Small Disturbance

Earthquakes, volcanic eruptions, and landslides are other types of natural disturbances that cause waves. These large-scale phenomena can cause tidal waves or tsunamis—enormous and destructive waves. The Sun and the Moon also cause ocean water to move. This movement is known as the tides—the gravitational influence of the Sun and Moon on the oceans.

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# What is the average speed of surface ocean currents?

OCEANS AND SEAS

1. 3-30 inches (7.5-75 cm) per second
2. 7-70 inches (17.5-175 cm) per second
3. 10-100 inches (25-250 cm) per second

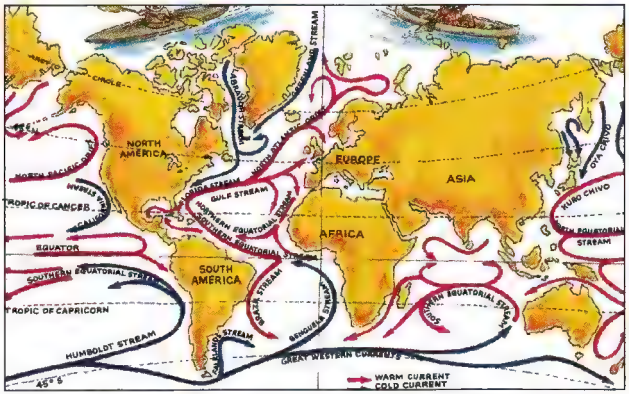
Illustration Gary Fields

©1996 Nintendo

# Ocean Currents

**The pattern of ocean water circulation causes exchanges of waters with different characteristics such as temperature and salinity – the amount of salt in the water.**

**1** **A characteristic surface speed is about 3 to 30 inches (7.5 to 75 cm) per second.**




Major ocean currents are mainly caused by wind and Earth's rotation.

Horizontal movements in the water are called currents, which range in magnitude from a few inches (cm) per second to as much as 5 yards (4.55 m) per second. This circulation is caused mainly by the winds and the rotation of Earth.

Ocean waters also have vertical movements, often called upwelling and downwelling. These movements take place at a much slower speed, typically amounting to only a few yards (m) per month. This deeper circulation of the oceans takes place because of differences in the density of neighboring water masses.

## Water Density

A water's density is determined by how salty it is and by how warm or cold it is. Evaporation of water at the surface increases the salinity, and the density, and causes the water to become heavier than the less salty water under it. This surface water then sinks, and very slowly the deeper waters replace those closer to the surface and vice versa.

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# What is an estuary?

OCEANS AND SEAS

1. A place where fresh water and salt water mix
2. A piece of laboratory equipment
3. An oriental botanical garden

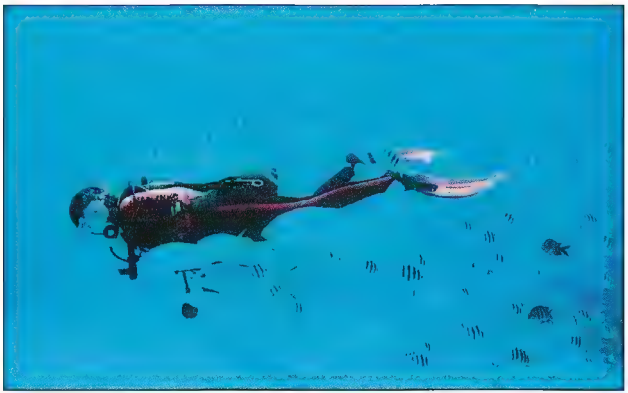
Illustration: Gary Fields

©1996 Nintendo

# Estuary

**There are usually three overlapping zones in an estuary: an open connection with the sea where marine water predominates, a middle area where strong salt water and fresh water mix, and a tidal river zone where fresh water predominates.**

**1** **An estuary is a semi-enclosed coastal area where seawater mixes with fresh water from rivers.**



© Len Sirman

Estuaries are highly productive ecosystems and home to one-half of the living matter in the world's oceans.

To survive in estuaries, aquatic animals must have physiological or behavioral adaptations to changes in salinity, the amount of salt in the water. Many oceanic species are able to move inward during the low-water season of rivers, when the salinity of estuaries increases. Freshwater fish move oceanward with the annual floods.

**Other Species**

There are also large numbers of invertebrates, or animals without backbones, living in estuaries. Fish, crabs, and shrimp take advantage of their presence, finding a readily available food supply. This extremely high productivity makes the estuary an attractive nursery habitat for many crustacean and fish species.

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# What is a tsunami?

OCEANS AND SEAS

1. A large salt-water fish
2. A large ocean wave
3. A small sail boat

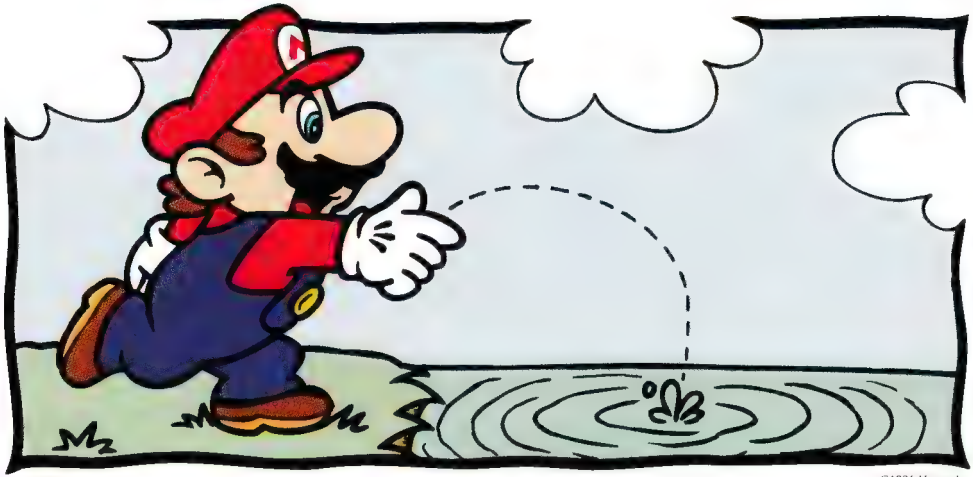

Illustration Gary Fields

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# Tsunamis

**Tsunami, a Japanese word, is the scientific term for a seismic sea wave, thought to be triggered when the ocean floor is tilted or offset during seismic activity, such as an earthquake, an undersea landslide, or volcanic eruption.**

## 2 A tsunami is a large ocean wave generated by an undersea earthquake.

© Len Sirman

Tsunamis are sometimes confused with tidal waves, though they have nothing to do with the pattern of high and low tides.

Most tsunamis start around the "Ring of Fire," a zone of volcanoes and seismic or earthquake activity that is 24,000 miles (38,400 km) long, encircling the Pacific Ocean. Since 1819, about 40 tsunamis have struck the Hawaiian Islands.

**Dangerous and Powerful**

A tsunami may travel hundreds of miles across the deep ocean, reaching speeds of around 450 to 500 miles per hour (720-800 km/h)! When the wave reaches the shallow coastal waters, it grows rapidly from its height of a yard or two out at sea. By the time it reaches the shore, it may become a towering wall of water 50 feet (15 m) high or even more! Tsunamis can destroy entire coastal communities.

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# What is scuba diving?

OCEANS AND SEAS

1. Underwater diving using a special suit
2. Underwater diving using an aqualung
3. Underwater diving using a face mask and flippers

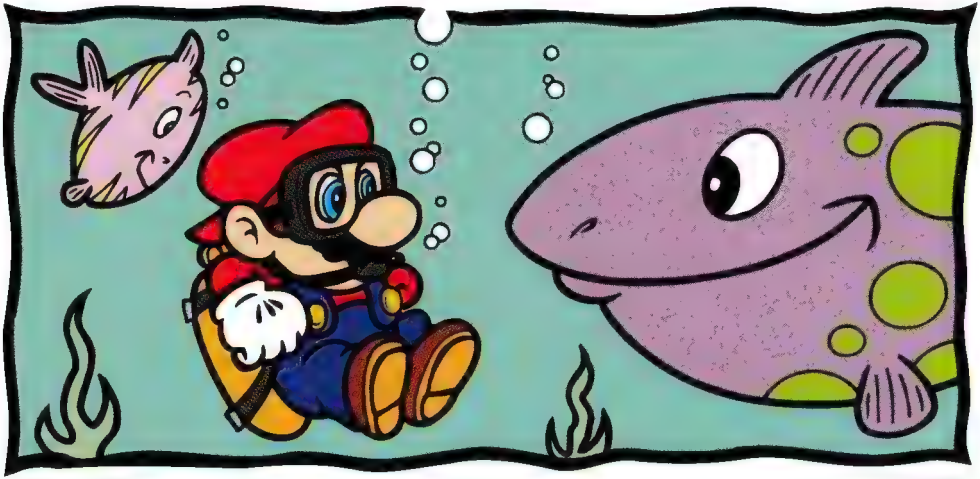

Illustration: Gary Fields

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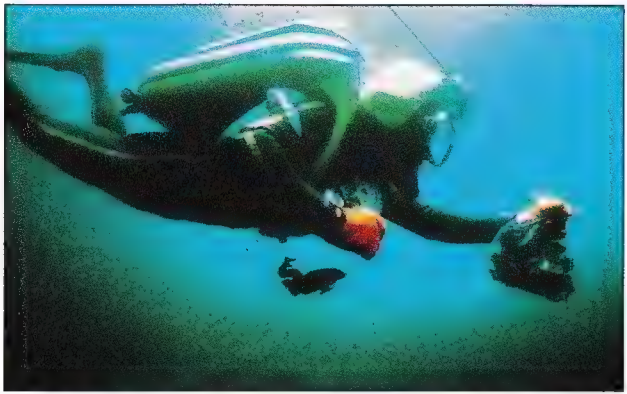
# Scuba Diving

**Scuba stands for self-contained underwater breathing apparatus. The first completely automatic compressed-air scuba was invented by Jacques Cousteau in 1943.**

## 2 Scuba diving is a form of underwater diving using an aqualung.



© Len Sirman

Thanks to scuba gear, a diver can spend more time exploring and photographing the wonders of life beneath the sea.

It was frogmen who first used scuba gear on an extensive basis. Frogmen were World War II military personnel who worked underwater as demolition and salvage experts, and also did scientific research. Today, many people enjoy scuba diving as a hobby. It allows us to explore the depths of the ocean, either for scientific purposes or simply for pleasure. While skin divers use a short above-water breathing tube, scuba divers use aqualungs, which are tanks filled with compressed air, which is released when a diver breathes.

**Scuba Pioneer**

You may be familiar with Jacques Cousteau, a French diver famous for undersea exploration and expeditions on his ship, the *Calypso*. During World War II, Cousteau invented the first fully automatic compressed-air self-contained underwater breathing apparatus or scuba.

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# What is an aqualung?

OCEANS AND SEAS

1. An underwater breathing apparatus
2. A lung used to train medical students
3. An emergency tank used in submarines

Illustration: Gary Fields

©1996 Nintendo

# Aqualung

**An aqualung supplies compressed air to divers and allows them to stay below the surface of the water for quite a long time. An aqualung regulates air pressure so a diver can breathe properly under water.**

## 1 An aqualung is an underwater breathing apparatus.

© Edimédia

Divers rarely go down more than 100 feet (30 m) below the surface of the water because water pressure, which is greater than air pressure, increases with depth.

Aqualungs are tanks that are filled with compressed air, which is released only when a diver takes a breath. In this way, the air supply lasts longer than it would if airflow were unrestricted. The aqualung also regulates the pressure of the released air and makes it easier for the diver to breathe in the intense water pressure.

### Scuba Safety

Diving can be very enjoyable, and it is much safer if scuba divers remember to follow safety procedures while exploring the undersea universe. Just as it is best to swim with a "buddy", it is best to dive with one, and it is important to come back up to the surface slowly to avoid any problems like dizziness or cramps which can occur during rapid changes of air and water pressure.

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# What separates the Mediterranean Sea from the Atlantic Ocean?

OCEANS AND SEAS

1. Bass Strait
2. Strait of Gibraltar
3. Long Strait

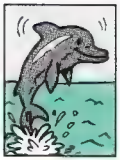
Illustration: Gary Fields

©1996 Nintendo

## Strait of Gibraltar

**At the Strait of Gibraltar's narrowest point, there are only 8 miles (13 km) of water between the southern tip of Spain and northwestern-most Africa.**

# 2 The Strait of Gibraltar separates the Mediterranean Sea from the Atlantic Ocean.



© ERL / Sipa Icono

Standing at the Strait of Gibraltar's narrowest point, in Spain, you can see across the water to Africa.

The Strait of Gibraltar is a 36-mile (58-km) channel whose waters average 1,200 feet (365m) in depth. The Romans called it the "Pillars of Hercules" because the Rock of Gibraltar on the north coast (Spain) and Mount Hacho on the south coast (Morocco) looked like pillars rising from the water. At the height of ancient Roman civilization, those pillars marked the strait's western boundary. The Strait of Gibraltar still serves as a major shipping route between southern Europe, northern Africa, and western Asia.

### Preserving the Mediterranean

A great deal of water is exchanged through the strait. More water flows eastward, from the Atlantic Ocean to the Mediterranean Sea, than westward. The surplus prevents the Mediterranean from becoming a shrinking salt lake. The winds in the strait are either from the east or the west. The easterly wind is called the levanter.

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# What is the Bermuda Triangle?

OCEANS AND SEAS

1. A percussion instrument
2. A cluster of islands in the Caribbean
3. A section of the Atlantic Ocean

Illustration Gary Fields

©1996 Nintendo

# Bermuda Triangle

**More than 50 ships and 20 airplanes are said to have disappeared over the Bermuda Triangle.**

## 3 The Bermuda Triangle is a section of the Atlantic Ocean.

© ERL / Sipa Icono

Despite its history, the Bermuda Triangle is one of the most heavily traveled ocean routes in the world.

The Bermuda Triangle is a zone in the Atlantic Ocean bordered by the southern United States coast, Bermuda, and the Greater Antilles. It has been steeped in mystery since the mid-19th century, when ships sailing through the region began to disappear. Some ships were found abandoned and others disappeared completely without even sending out distress signals. Aircraft and rescue missions alike have vanished while flying over the area.

**History of Mystery**

Scientific searches of the Bermuda Triangle have not revealed anything to explain why some vessels simply vanish when they pass through the area. Some people believed the vessels had disappeared into another dimension or were abducted by space aliens. But in 1991, when divers recovered five U.S. Navy bombers that had been lost in the area in 1945, some of the more unusual theories may have been put to rest.

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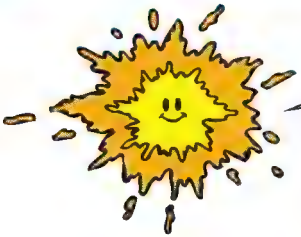
# What is the second largest ocean?

OCEANS AND SEAS



1. Pacific Ocean
2. Atlantic Ocean
3. Arctic Ocean

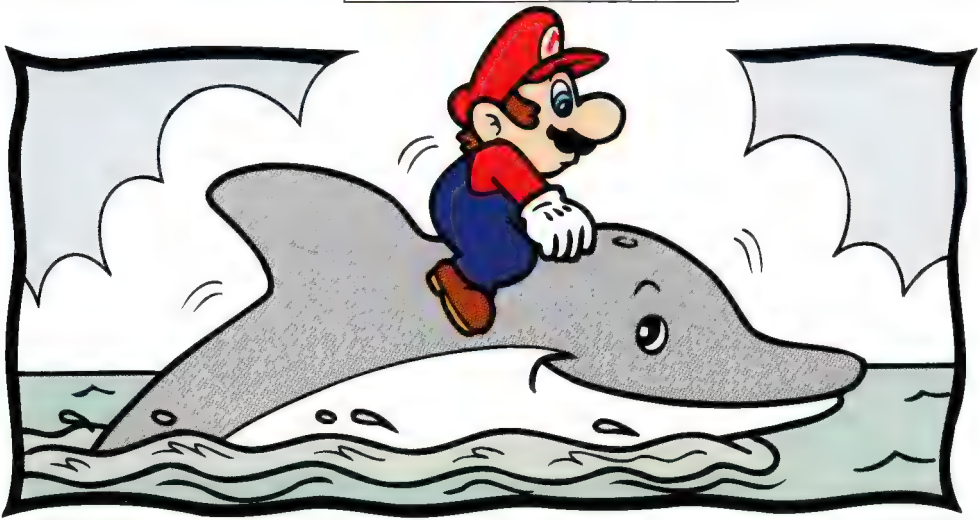


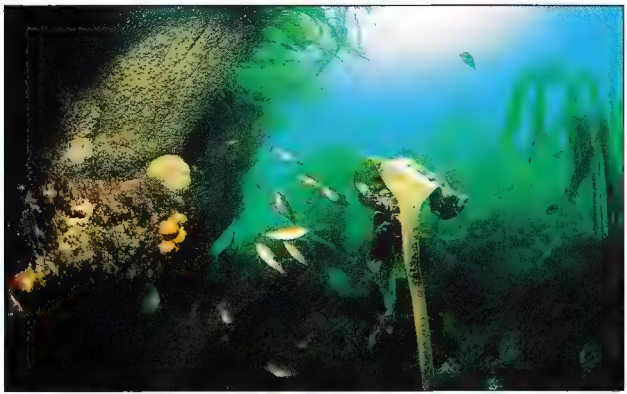
Illustration: Gary Fields

©1996 Nintendo

## Atlantic Ocean

The average depth of the Atlantic Ocean is approximately 12,100 feet (3,700 m). It covers about 32 billion square miles (82 billion sq km), or about 20 percent of Earth's surface.

# 2 The Atlantic Ocean is the world's second largest ocean.



© Y. Gladu / Explorer

Many of the world's rivers empty into the Atlantic Ocean. These rivers provide nutrients that support a wide variety of marine flora and fauna.

The Atlantic extends from North and South America in the west to Europe and Africa in the east. It is linked to the Pacific Ocean by the Arctic Ocean in the north and Drake Passage in the south. The Atlantic also meets the Pacific at the Panama Canal, a manmade waterway. The Atlantic Ocean is deepest at Puerto Rico Trench, where it dips to 27,498 feet (8,381 m). There are relatively few islands in the Atlantic. Some of the most notable are Greenland, Iceland, the British Isles, Bermuda, the Falkland Islands, the Canaries, and the Azores.

**Ocean Floor**

The main feature of the Atlantic Ocean floor is the Mid-Atlantic Ridge, an undersea mountain range. In most places, the water above the mountain range is less than 8,900 feet (2,000 m) deep. A few of the peaks in the Mid-Atlantic Ridge rise above the water to form islands.

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# Why is the ocean blue?

OCEANS AND SEAS

1. Because of the way it reflects sunlight
2. The water is tinted blue
3. The sand on the bottom is blue

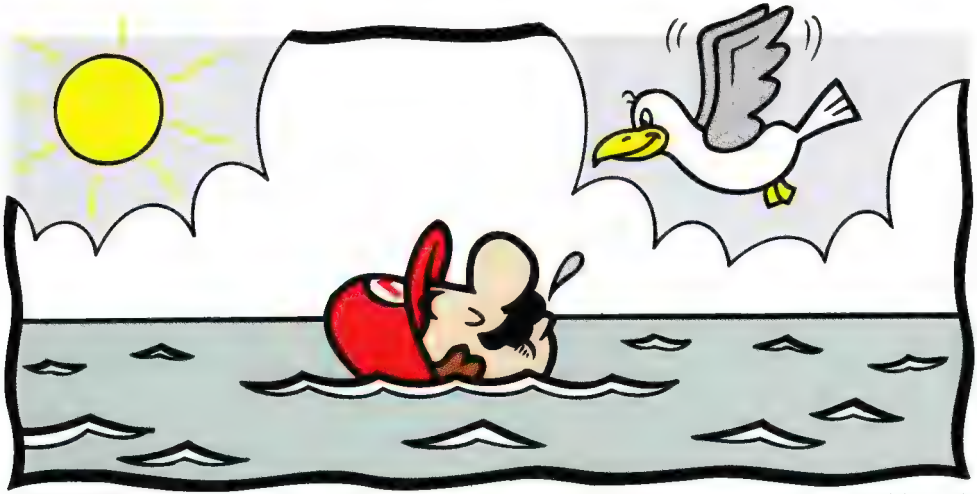

Illustration: Gary Fields

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# Ocean Colors

**Not all oceans are blue. Their colors vary depending on the depth of the water and the plant life it contains.**

**1 The ocean is blue because of the way it reflects sunlight.**

© M. Hosken / Explorer

In the Caribbean, ocean water is brilliant turquoise. The color of the ocean varies, depending on its depth and the plant life it contains.

Light appears to be white, but it's really made up of rays of different colors—red, orange, yellow, green, blue, and violet. When sunlight strikes the ocean, all of the rays are absorbed except the blue rays. These are scattered and returned to the surface where they are reflected. The blue color we see is actually the reflection of the blue rays of light from the sun.

Plant life affects water color, too. Floating near coastlines are tiny green plants and bits of organic material called phytoplankton. All that green matter in the water can make the ocean look green.

**Underwater**

Water's color grows darker the deeper you go. This is because more and more light rays have been absorbed. Very deep in the ocean, the water can appear to be dark blue. This is why scuba divers often carry lights with them when they dive deep. Snorklers, who swim near the surface, use the light of the sun to see underwater.

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# Do oceans change in size and shape?

OCEANS AND SEAS

1. Yes, continents shift and this changes the shape of oceans.
2. No, oceans have been the same size and shape forever.

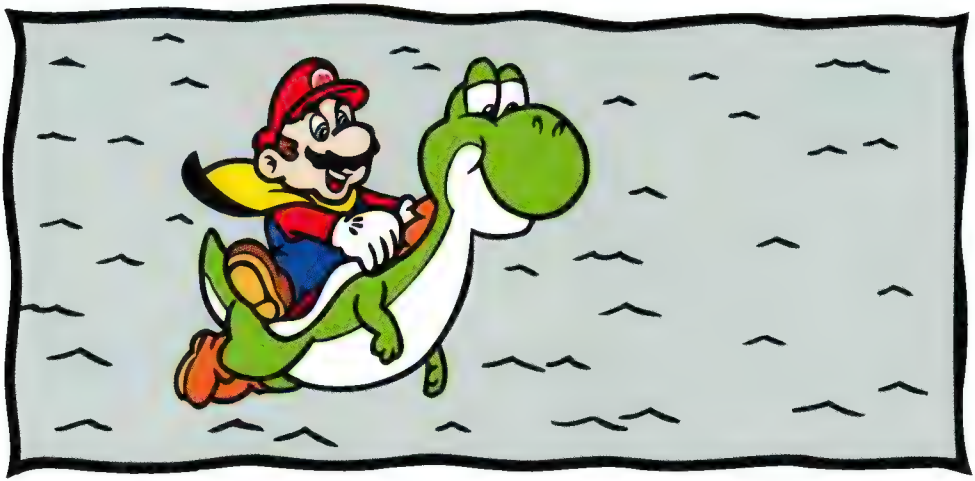

Illustration: Gary Fields

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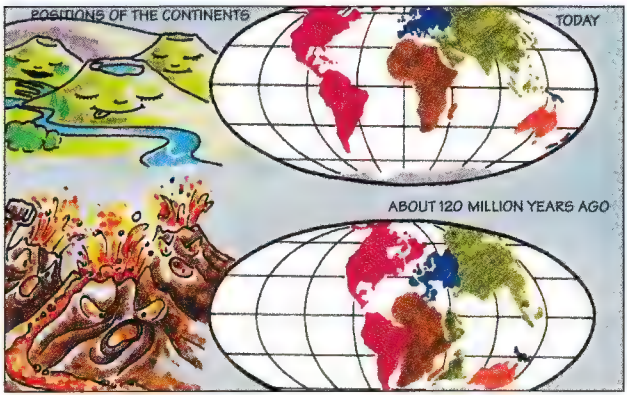
# Plate Tectonics

**In the 1920s, German meteorologist Alfred Wegener proposed that Earth's continents once were one land mass that broke apart. In the 1950s, geologists found he was right.**

## 1 The slow shift of the continents changes the size and shape of oceans.




© Y. Tabariés

Wegener pointed out that the shapes of Earth's continents can almost be fit together like a jigsaw puzzle.

Comparing samples of rock from different parts of the world, geologists noticed similarities. This led them to believe these rocks were once found on the same land mass. Over time, and very slowly, the land mass broke up and drifted apart. Continental land masses are still moving—a few inches each year. As they move, they change the size and shape of the bodies of water that surround them. Eventually, some waterways might close and new ones open.

### Causes of Motion

Geologists aren't sure what makes continents move. It could be the same subterranean energy that causes earthquakes and volcanic activity. The land masses, anchored to the ocean floor, are called tectonic plates. When the plates move apart, molten rock is released from beneath Earth's surface creating new areas of ocean floor. When plates collide they create trenches and ridges beneath the ocean.

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# What determines the density of water?

OCEANS AND SEAS

1. Depth and temperature
2. Salinity and temperature
3. Color and temperature

Illustration: Gary Fields

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## Water Density

**Density is the mass of a substance in relation to its physical volume. Basically, this refers to how thick or "crowded" with molecules a substance is.**

## 2 The density of water is determined by salinity, or salt content, and temperature.

© Len Sirman

The salt water of an ocean is more dense than the fresh water of an inland stream.

Salt water is more dense than fresh water. The more salt the water contains, the more dense it becomes. So, in technical terms, the greater the water's salinity, the greater its density.

### How Density Works

Open, porous substances that are less dense than water, such as cork and wood, will float in water. Substances that are more dense than water, such as rocks, will sink.

### Effect of Temperature

Bodies of water in hot, dry regions tend to be more dense than bodies of water in humid regions. This is because water evaporates quickly in dry heat, leaving only salt behind. The Dead Sea, on the border of Israel and Jordan, is one of the most dense bodies of water on Earth. It's seven times saltier than a typical ocean, and it's so dense almost everything floats on it.

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# What was the *Challenger* oceanography expedition?

OCEANS AND SEAS

1. First expedition to map the ocean floor
2. First expedition to reach the North Pole
3. First expedition to tag sharks

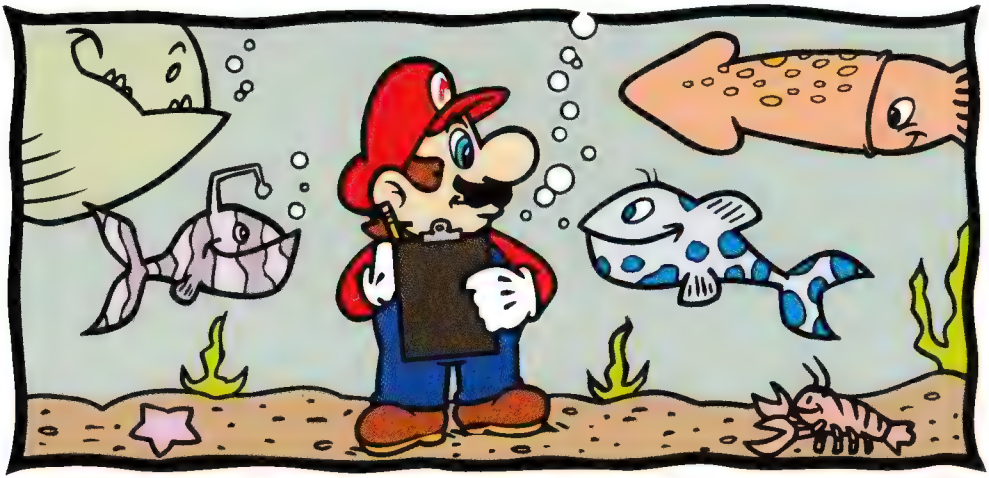


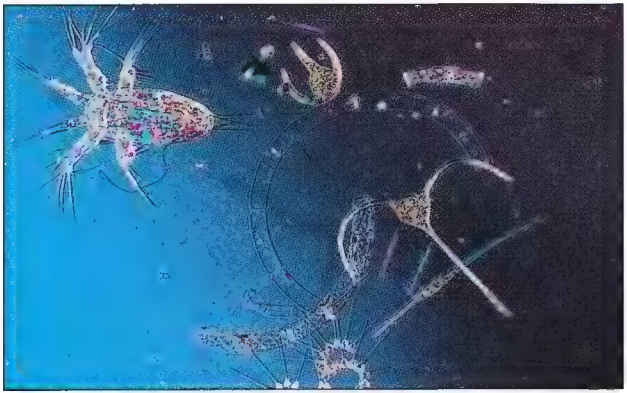
Illustration: Gary Fields

©1996 Nintendo

## HMS *Challenger*

**In 1872, the English government financed a scientific expedition to study the world's oceans. The ship, HMS *Challenger*, spent almost four years on this mission.**

# 1 The *Challenger* expedition was the first to map the ocean floor.



© C. Carre / Jacana

Some of the new organisms discovered by the *Challenger* expedition were microscopic creatures like these.

The work done by the crew of the *Challenger* is considered to be the basis for the modern study of oceanography. The expedition studied water and marine life of the Atlantic, Pacific, and Indian oceans, and traveled more than 69,000 miles (110,400 km). In the process, the *Challenger* discovered 4,417 new species of aquatic plants and animals.

**Floating Laboratory**

One of the purposes of the expedition was to confirm and add to scientific data that other scientists had found. For example, the *Challenger* mapped the length of the Mid-Atlantic Ridge, an underwater mountain range. Other expeditions had encountered different parts of it, but the *Challenger* was the first to chart the whole range. The *Challenger* also charted the circulation of ocean waters, by following the path of very cold Antarctic currents and studying ocean temperatures at various depths.

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# Can mining be done underwater?

OCEANS AND SEAS

1. Yes, commercial mining is done underwater.
2. No, it's impossible to dig mines underwater.
3. Maybe. Geologists and engineers are experimenting now.

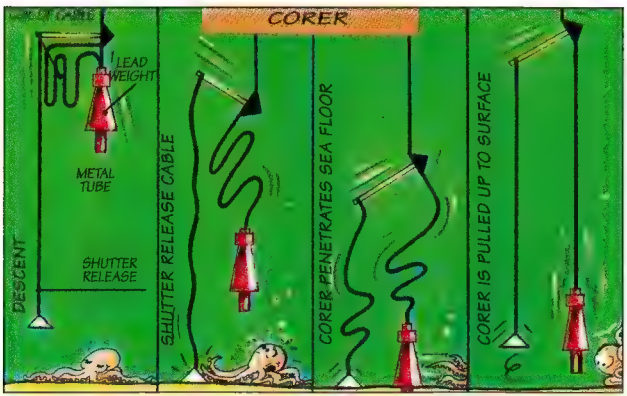
Illustration: Gary Fields

©1996 Nintendo

## Underwater Mining

**Offshore drilling, in which petroleum is extracted from under the sea floor, has been done since 1947. Methods are being devised to extract other resources from under the sea as well.**

**3** **Large-scale commercial mining is not done underwater yet, but it may be done soon.**




How a corer works.

The sea floor and the layers of Earth below it contain all sorts of mineral resources—including gold and diamonds. Some minerals, such as sodium and magnesium, are found in sea water itself. Chemists can collect the sea water and extract the minerals from it. As for collecting minerals from under the sea floor, geologists and engineers are still working on a way to do it efficiently and safely.

### Marine Core

To determine what the sea floor is made of—and what minerals it contains—oceanographers take samples of the sea floor using a device called a corer. A corer is attached to a cable and lowered to the sea floor. The weight of the corer drives its tip into the sea floor where it collects a sample of rocks and sand. Then the corer is reeled up to the surface and the sample is taken to a lab for analysis.

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# What is a Nansen bottle used for?

OCEANS AND SEAS

1. Carrying fresh water on long voyages
2. Storing flammable liquids on a ship
3. Taking samples of ocean water for

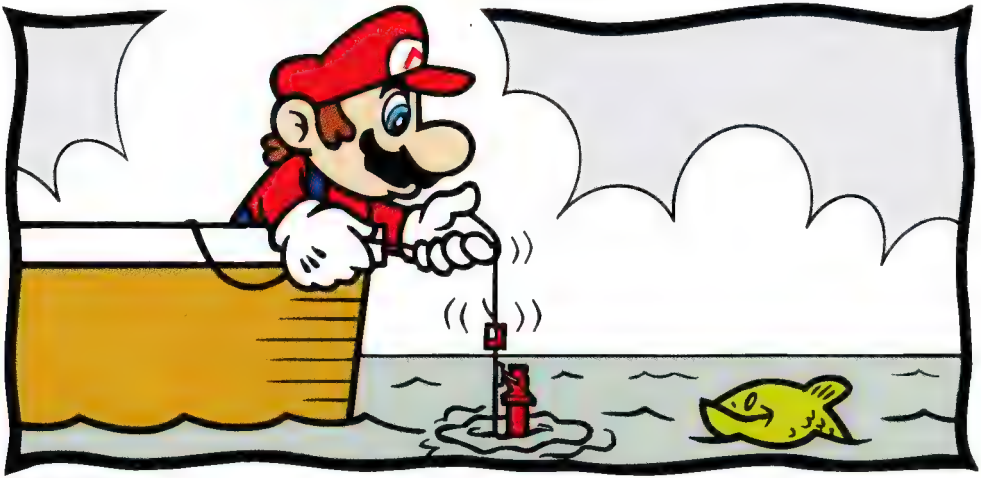


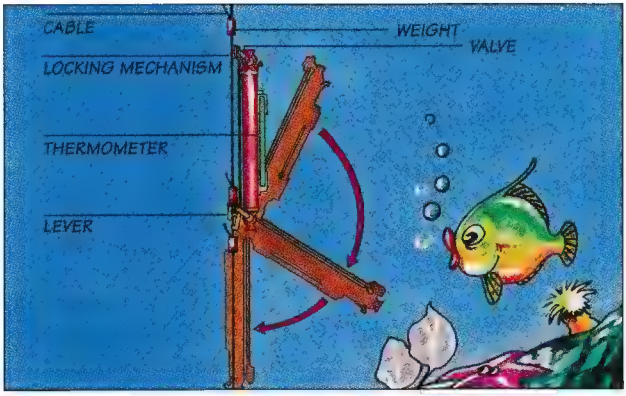
Illustration: Gary Fields

©1996 Nintendo

# Nansen Bottle

**Norwegian explorer and oceanographer Fridtjof Nansen invented the Nansen bottle.**

## 3 A Nansen bottle is used to take samples of ocean water for research.




The Nansen bottle was invented more than 60 years ago, and it's still used today.

Analyzing water samples is an important part of an oceanographer's work. Water is tested for salt content or salinity, temperature, and the microorganisms it contains. These factors determine the plants and animals the water can support.

**Solution to a Problem**

Because temperature and mineral content vary at different depths, oceanographers take water samples from different depths. To do this, they can't just lower an open bucket into the water and draw it back up—by the time it reached the surface, it would contain water from different depths. The Nansen bottle solves this problem. It's sealed underwater so the sample remains pure.

**How it Works**

An open Nansen bottle is lowered by cable to the desired depth, where it fills with water. Then a small weight slides down the cable triggering a closing mechanism that seals the bottle. The sealed sample is then pulled to the surface for analysis.

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# Where was the first offshore oil well?

OCEANS AND SEAS

1. Arabian Sea
2. Gulf of Mexico
3. Indian Ocean

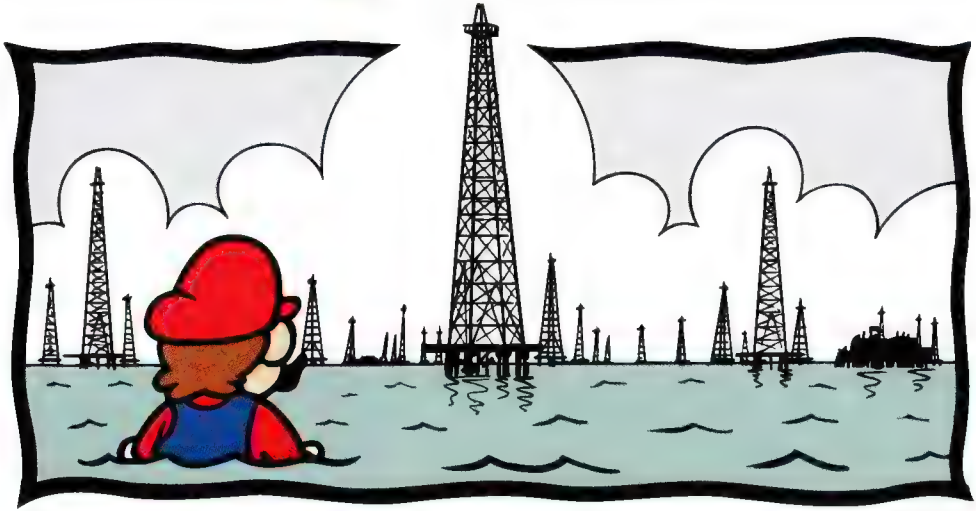

Illustration: Gary Fields

©1996 Nintendo

# Offshore Drilling

**Crews that live and work on offshore oil rigs include specially trained divers who connect and repair underwater pipelines.**

## 2 The first offshore oil well was in the Gulf of Mexico near Louisiana.

© P. Maitre / Gamma

An offshore drilling site, like this one in the Gulf of Mexico, may have several wells.

The first offshore oil well was drilled in 1945. Today, offshore drilling is done all over the world.

**Changing Technology**

Offshore drilling to extract petroleum from beneath the sea floor has evolved and improved. Wells are drilled in deeper waters than ever before, and offshore drilling platforms, called rigs, are safer and sturdier than ever.

**Well, Well**

The most common type of offshore rig is a jack-up rig. These huge platforms, with long steel legs are towed into place by barges. Air-filled ballast tanks attached to the legs are opened so that they fill with water. The weight of the tanks drags the legs to the sea floor, then the legs are anchored to the floor with cables and the platform is jacked up, or raised into position above the water's surface.

Offshore drilling is also done from submersible platforms, which lie on the sea floor; and from floating drill ships.

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# What is a bathyscaphe?

OCEANS AND SEAS

1. A vehicle for deep-sea exploration
2. A controlled environment in an oceanography lab
3. A sea turtle bred in captivity

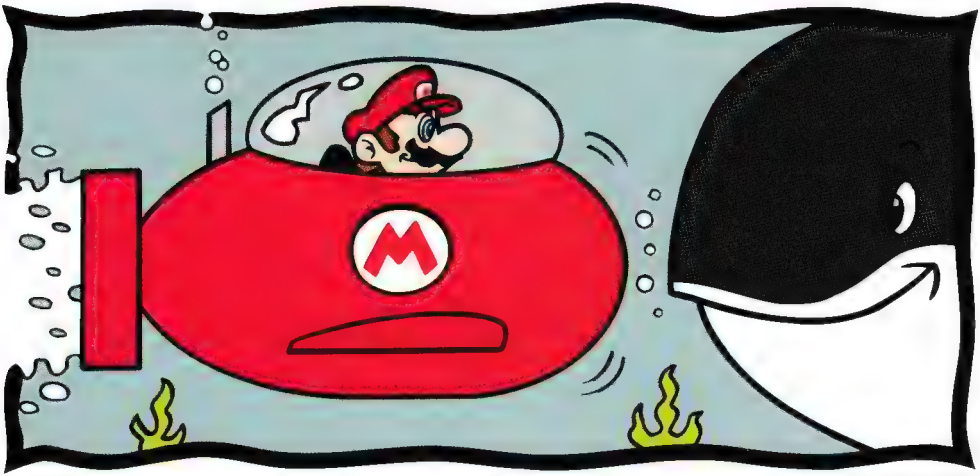

Illustration: Gary Fields

©1996 Nintendo

# Bathyscaphe

**A bathyscaphe carried two people to the bottom of the ocean, where they collected samples of water and sand, conducted experiments, and observed under-sea life.**

## 1 A bathyscaphe is a vehicle for deep-sea exploration.

© Len Sirman

A bathyscaphe, big enough to hold two people, had mechanical arms that could be used to collect samples underwater.

The bathyscaphe was an improved version of the bathysphere, built by Americans Otis Barton and William Beebe. A bathysphere was a round, hollow metal ship lowered into the ocean on cables.

There were two problems with the bathysphere. First, once it was underwater, it couldn't move. More importantly, if the cables holding the bathysphere broke, it couldn't be raised to the surface.

### Improvements

The bathyscaphe, designed by Swiss physicist Auguste Piccard, was self-propelled. It descended by means of ballast tanks that filled with water to make it heavy enough to sink. Once underwater, the bathyscaphe could move around, within a limited range. In 1960, the bathyscaphe *Trieste* made its deepest dive ever—35,800 feet (10,912 m) into the Pacific Ocean's Mariana Trench.

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# What is a trawler?

OCEANS AND SEAS

1. A barge that carries cargo
2. A speedboat for racing
3. A type of fishing boat

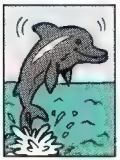
Illustration: Gary Fields

©1996 Nintendo

# Trawler

**Trawling is a fishing technique in which nets are used to catch fish that swim near the bottom of the ocean.**

## 3 A trawler is a fishing boat.



© Dupont / Gamma

Early trawlers were sailing vessels. Modern trawlers are diesel-powered boats that use sonar to locate schools of fish swimming deep below the ocean's surface.

Nets used for trawling are called trawls. They're shaped like bags—closed at one end. The open ends of the net are attached to lines connected to the boat. As the boat moves through the water, the net is dragged behind it. At a designated time, the net is hoisted up and the closed end, called the cod-end, is opened to release the fish onto the deck of the boat. As you've probably guessed, cod is one of the fish commonly caught by trawling.

**Scraping the Bottom**

To catch fish and crabs that burrow in the ocean floor, trawls are equipped with "tickler chains" that drag along the ocean floor and rouse them from their burrows. As the fish rise, they're trapped in the net.

During the First and Second World Wars trawlers were used as minesweepers. Their "bottom-fishing" techniques were useful for finding explosive mines buried in the ocean floor.

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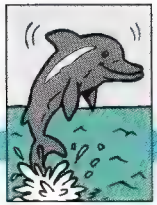
# What is the primary cause of water pollution?



OCEANS AND SEAS

1. Chemical runoff
2. Dead fish
3. Green algae

Illustration: Gary Fields

©1996 Nintendo

# Water Pollution

**When chemicals and foreign matter—like garbage—are introduced to lakes and rivers, they cause ecological changes that harm or kill animals and plants.**

**1 Chemicals, such as pesticides, are the main cause of water pollution.**

© Corder / Explorer

Garbage dumped into rivers and lakes is water pollution that you can see. The chemicals pumped into our waterways can be even more dangerous to the environment.

A community of plants and animals that live in a particular environment, such as a lake, is called an ecosystem. Every creature and plant within an ecosystem depends on the others for its survival. Water pollution upsets the ecosystem's balance by introducing chemicals and foreign matter to the water.

**Chemical Runoff**

Some chemicals are pumped directly into the water as waste from factories. Others are carried by rain and melting snow into lakes and rivers. Imagine a cornfield that has been sprayed with pesticides. Rainwater washes away some of the pesticide. Eventually, that dirty rainwater flows into storm drains that carry it to rivers, lakes, or the ocean. Household chemicals, like detergent and cleansers, go down the drain and out to sea in the same way.

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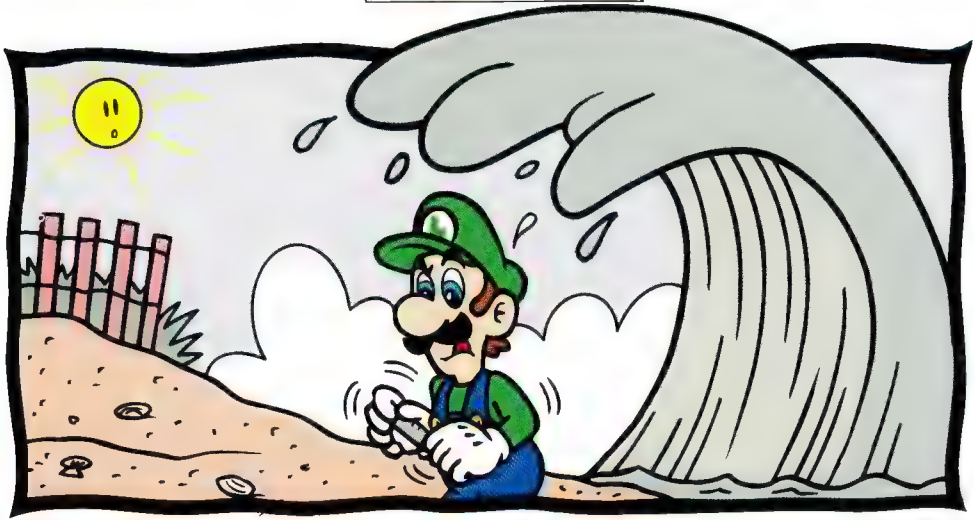
# What is the main cause of ocean waves?

OCEANS AND SEAS

1 Salt

2 Sand

3 Wind



Illustration, Gary Fields

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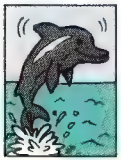
# Waves

**In oceanographic terms, a vast stretch of ocean where waves are produced is called a fetch. Wind blowing across the fetch creates waves.**

## 3 Wind is the primary cause of ocean waves.



© Len Sirman

The waves that break on the coastline come from swells created at sea.

The size of the waves depends on the strength of the wind and the size of the fetch. The larger the fetch, the more space the wind has to whip up water into waves. In the world's great oceans, the Atlantic and Pacific, the fetch can be so large that waves grow into tremendous swells, that continue to send off ripples long after the wind has died down.

**Motion of the Ocean**

Even though waves appear to be traveling, the water actually stays in one place. A wave drives water up and around in a circular pattern. The motion creates more waves which create even more waves. The process continues until the waves reach the shore.

**Around the World**

Waves generated by a big ocean swell can sometimes go on for thousands of miles. Storms in the South Pacific can make the waves that reach the California coast.

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# Where do most tidal waves occur?

OCEANS AND SEAS

1. Atlantic Ocean
2. Pacific Ocean
3. Yellow Sea

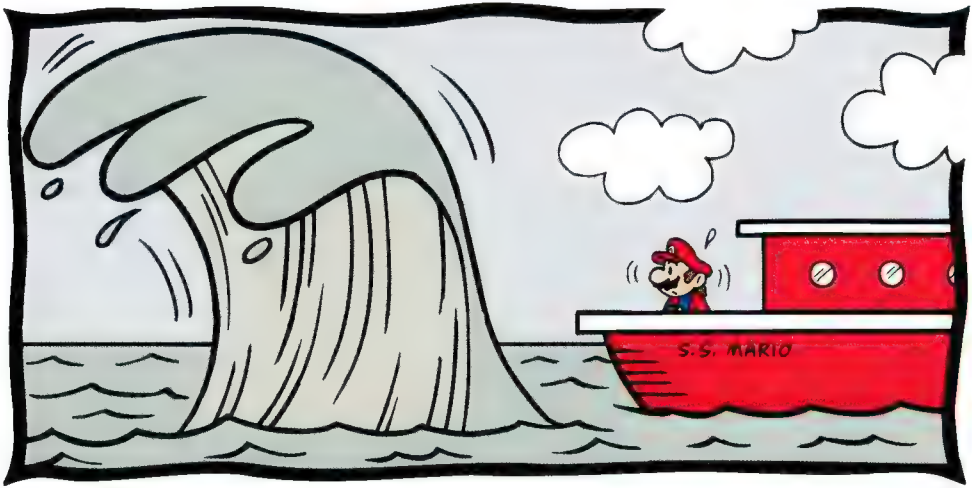


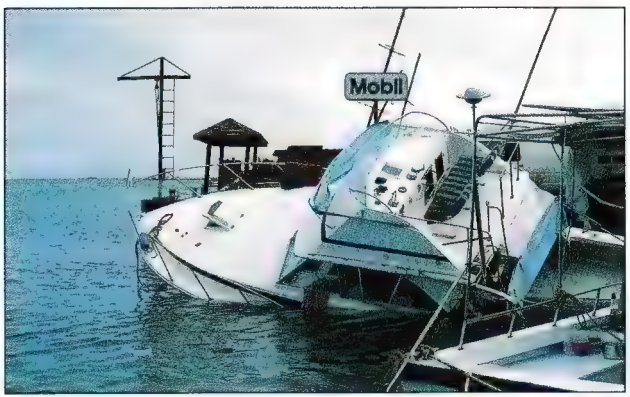

Illustration: Gary Fields

©1996 Nintendo

## Tidal Waves

**The correct name for a tidal wave is tsunami. Tsunamis are caused by underwater earthquakes and are not related to tides.**

## 2 Most tidal waves occur in the Pacific Ocean.




© Aries / Gamma

Tsunamis can destroy marinas and moorings along coastlines. They cause floods and destruction on land as well.

Earth's surface beneath the ocean is similar to Earth's surface on dry land. It has mountains and valleys, and it also has cracks, or faults, caused by shifts in Earth's crust. Occasionally, the crust shifts further, creating the phenomenon we call an earthquake.

When earthquakes occur underwater, they create ocean waves above the quake site, as the water is displaced or shifted from its position.

### Wall of Water

The waves are not large at first, but the force of the earthquake causes them to gather speed and power. Tsunamis can travel at 500 miles per hour (800 km / h) in deep water.

Shallow water near shore forces the waves to slow down. But the force of the fast-moving ocean waves is so great that the water rises up into a wall more than 100 feet (30 m) high. Then the wall of water crashes down on shore, causing flooding and destruction.

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# What is sonar?

OCEANS AND SEAS

1. A method of detecting objects underwater
2. A method of fishing using wooden traps
3. A form of competitive sailing

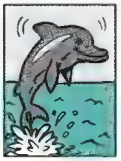
Illustration Gary Fields

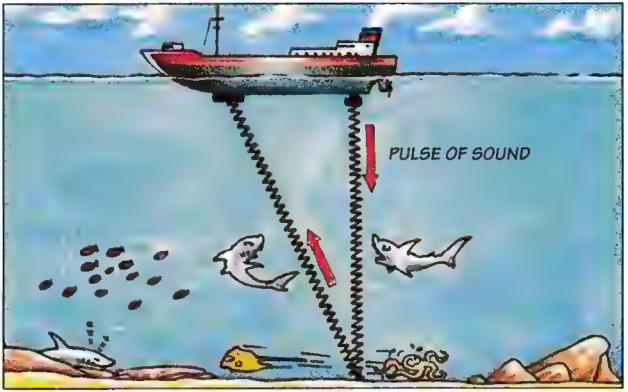
©1996 Nintendo

# Sonar

**The word sonar stands for "sound navigation and ranging." Sonar, or echolocation, uses sound waves to find or identify objects underwater.**

## 1 Sonar is a method of detecting objects underwater.






Ships can use sonar to determine the depth of the ocean. The ship releases a pulse of sound that travels to the ocean floor and then bounces back up. The time it takes for the pulse of sound to return to the ship indicates the distance it traveled to hit the ocean floor.

Naval ships and submarines use sonar to detect enemy submarines, torpedoes, and mines in the water and sea bed below or around them. Fishing boats use sonar to locate schools of fish swimming deep below the ocean's surface. Oceanographers use it to chart the depth of the ocean. Explorers and treasure hunters use it to search for unusual items on the sea floor, such as sunken ships and treasure.

### Pulses and Echoes

To activate sonar, a ship releases a pulse of sound into the water. The sound waves travel through the water until they contact a solid object. They bounce off the object and echo back through the water. The sonar equipment on the ship detects the echoes. The delay between the time the ship released the pulse and the time the echo returns indicates the distance between the ship and the submerged object.

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# Is all beach sand the same color?

OCEANS AND SEAS

1 Yes

2 No

Illustration: Gary Fields

©1996 Nintendo

# Sand

**Beach sand can be white, tan, pink, gray, or black. It all depends on the sand's mineral content.**

## 2 No, beach sand differs in color.

© Marge / Sunset

The sand on most of Earth's beaches is made of the mineral quartz.

The island of Bermuda, in the Atlantic Ocean, is famous for its pink sand beaches. The pink specks in the sand are actually bits of red foraminifer, a shell that is found in offshore reefs. It mixes with powdery white sand, made from the calcium carbonate of decomposing shells, to form stunning stretches of pink beach.

**Volcanic Sand**

Among Earth's more remarkable sights are the black sand beaches of volcanic islands, such as Montserrat in the Caribbean. The sand is largely composed of basalt, a mineral remnant of volcanic eruptions.

**Beachcombing**

Most of Earth's golden sandy beaches are made of quartz or silica. Quartz doesn't erode easily, even in the constant flow of ocean waves. Some beaches aren't sandy at all. They're made of rocks or small pebbles. These rocky beaches are most common in colder coastal regions.

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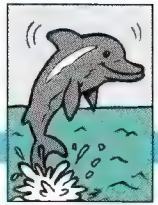
# Which animals are often caught by mistake in tuna nets?



OCEANS AND SEAS

1. Dolphins
2. Eels
3. Squid

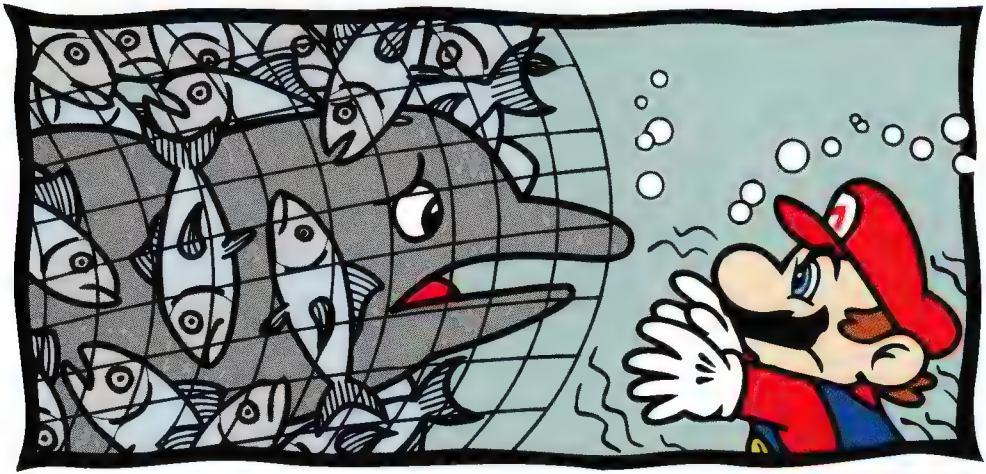


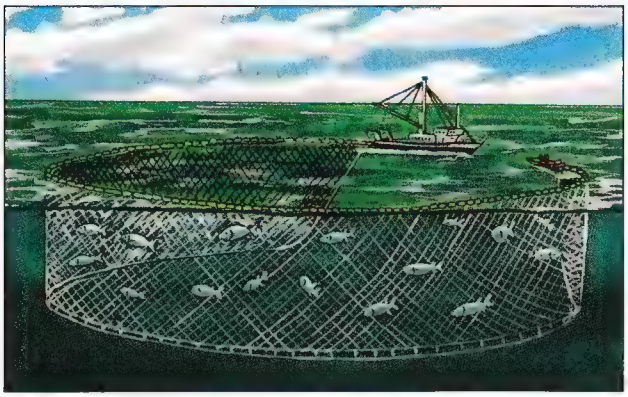
Illustration Gary Fields

©1996 Nintendo

# Tuna Fishing

**Tuna, one of the world's most popular food fish, travel in large schools near the surface of the ocean. It's not uncommon for dolphins to swim alongside the tuna.**

## 1 Dolphins are often caught by mistake in tuna nets.



© Y Tabanés

A circular purse seine net is lowered from a fishing boat into the water. It surrounds the school of tuna. Unfortunately, it also traps dolphins that swim alongside the tuna.

Tuna fishermen use a large round net called a purse seine. The net is lowered into the water to surround the tuna. Then it's hauled up onto the fishing boat filled with fish. Dolphins that swim with the tuna are often caught in the nets as well.

Even though fishermen don't want to harm the dolphins, hundreds of thousands of dolphins died in tuna nets each year. Tangled in the nets, the dolphins couldn't come up to the surface for air and they drowned.

### Dolphin-Safe

In 1972, laws to protect dolphins went into effect. Some countries required fishermen to monitor their catches and to save the dolphins. The U.S. banned the use of purse seine nets. The number of dolphins killed in tuna nets decreased enormously. In 1996, the U.S. decided to allow purse seines to be used as long as no dolphins are killed in the catch.

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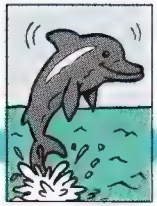
# What is noriculture?



OCEANS AND SEAS

1. Study of cold-water aquatic mammals
2. Seaweed farming
3. Artificial stimulation of nautical winds

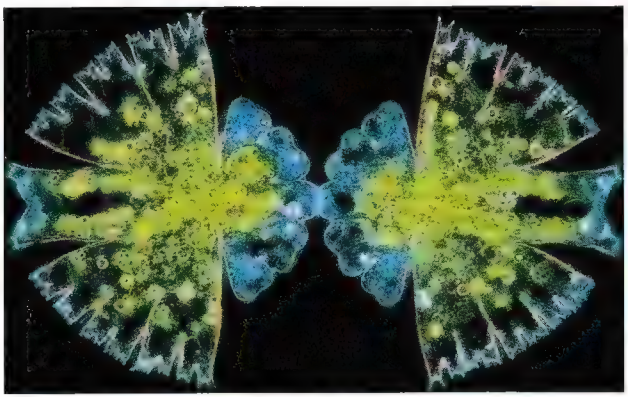
Illustration, Gary Fields

©1996 Nintendo

## Noriculture

**The Japanese word *nori* refers to a type of seaweed used as an ingredient in Japanese cooking. Noriculture is a term used to describe seaweed farming.**

## 2 Noriculture is another name for seaweed farming.



© N.H.P.A./Sunset

Algae, such as seaweed, is loaded with vitamins, minerals, and other nutrients. Chemists continue to find new uses for this versatile plant life. That's good news for seaweed farmers.

Why would people create farms to raise seaweed? It might sound strange, but seaweed is an important commodity in many industries. Fishermen harvest it where it grows naturally, but by setting up underwater seaweed farms they're always assured of a bountiful seaweed harvest. The first seaweed farming company in the U.S. is located in the state of Maine. The company specializes in growing nori, the seaweed used to make sushi and other Japanese foods.

**Versatile Vegetation**

Seaweed is also used to make a thickening agent that makes refrigerated pudding gel and ice cream harden to a smooth consistency. It may also be dried and ground up to make plant fertilizer and animal feed. And, because it's loaded with vitamins and minerals, it's now a popular ingredient in beauty products like shampoo, shaving cream, and skin lotions.

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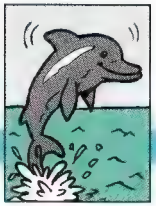
# What causes divers to get the "bends"?



OCEANS AND SEAS

1. Swimming with a full stomach
2. Changes in pressure
3. Seasickness

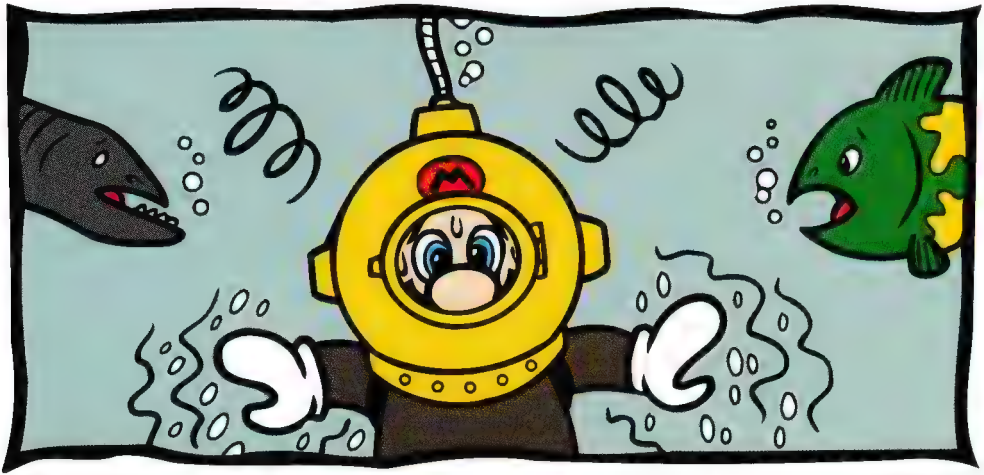


Illustration: Gary Fields

©1996 Nintendo

# The Bends

**As divers descend deeper and deeper beneath the ocean's surface, the atmospheric pressure around them increases. They accustom themselves to pressure changes by descending in stages.**

## 2 Pressure changes cause divers to get the bends.

© Len Sirman

Divers descend and ascend slowly, in stages, to accustom their bodies to pressure changes underwater.

When divers return to the surface they have to come up slowly, in stages, or the decrease in pressure could lead to a condition known as the "bends."

**Nitrogen Bubbles**

When divers spend time at depths of 30 feet (9.1 m) or more, their body tissues gradually fill with nitrogen. If they return to the surface slowly, the nitrogen has a chance to escape. If they come up too fast, the nitrogen gets trapped and turns to bubbles in the body tissue and blood vessels. The bubbles cause pain in the joints, weakness, a burning sensation in the lungs, and coughing. In severe cases, the diver may lose consciousness.

The bends is also known as caisson disease. A caisson is a watertight chamber which carries construction crews to do work underwater. If the caisson is raised too quickly, workers experience the bends.

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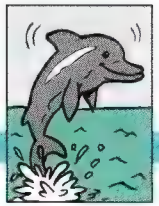
# Does the ocean floor contain mountains?



OCEANS AND SEAS

1. Yes, there are mountains on the ocean floor.
2. No, the ocean floor is perfectly flat.
3. Maybe, oceanographers don't know for sure.

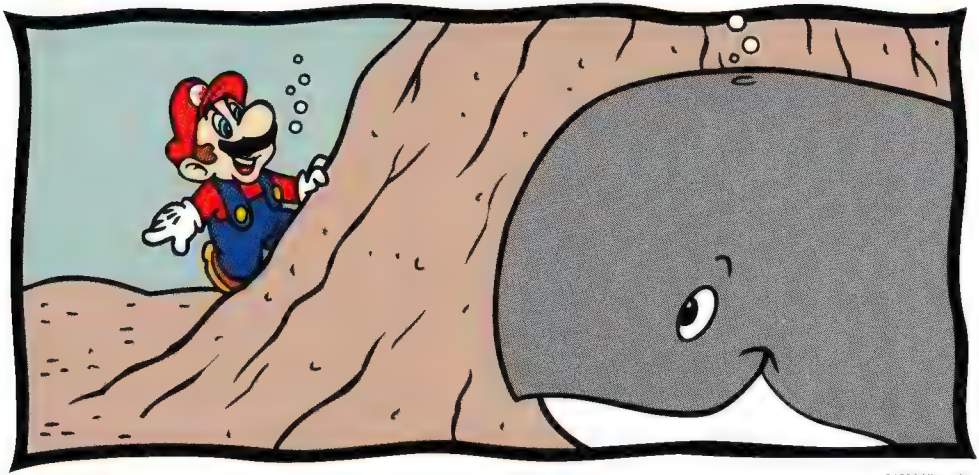


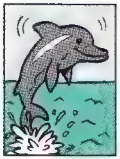
Illustration: Gary Fields

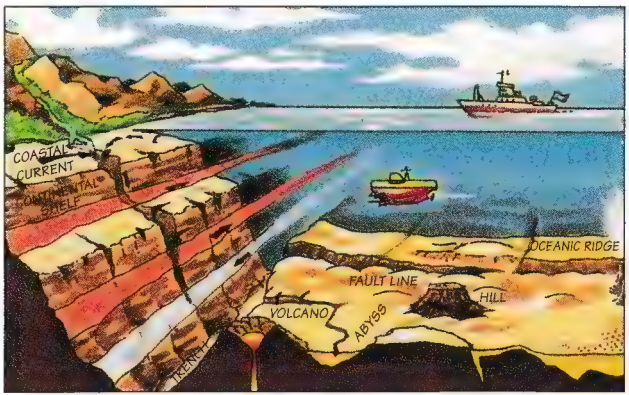
©1996 Nintendo

# Ocean Floor

**Just like Earth's land surface, the ocean floor has mountains, valleys, and plains. There are even underwater gorges and canyons, such as the Scripps Canyon off the coast of La Jolla, California.**

## 1 Yes, there are mountains on the ocean floor.






© Y. Takanés

The ocean floor is as varied as Earth's land surface, with mountains, valleys, and plains.

The area just off the coast of the continents is called the continental shelf. At the end of the continental shelf, about 40 to 60 miles (65-100 km) out to sea, the ocean floor slopes down again. This is known as the continental slope. It resembles the side of a mountain. At this point, the depth of the ocean may increase from 396 feet (120 m) to as much as 6.8 miles (11 km). There may also be canyons that cut into the slopes and the continental shelf.

**Plains and Trenches**

Beyond the continental slope are deep narrow trenches in the ocean floor. The deepest trench is the Mariana Trench, near the Mariana Islands in the Pacific Ocean. The rest of the ocean floor is comprised of vast flat plains and mountains. The tallest undersea mountains break the surface of the water as islands.

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# What is a continental shelf?

OCEANS AND SEAS

1. Relatively flat land off the coasts of continents
2. Pattern of winds that determine tides
3. A restricted commercial fishing area

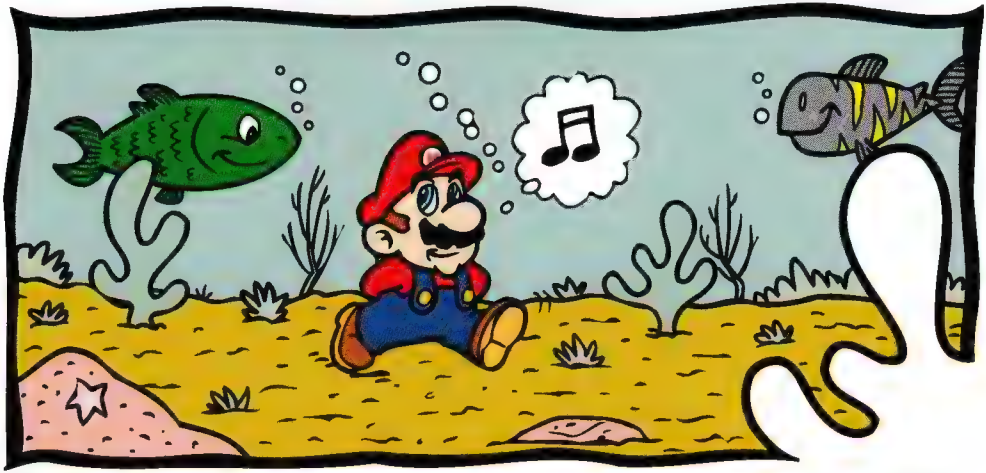


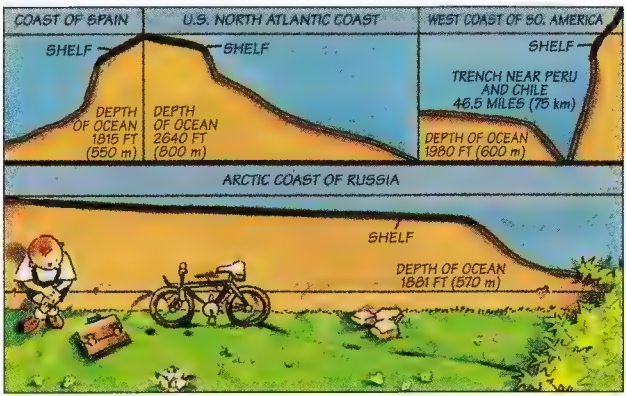
Illustration: Gary Fields

©1996 Nintendo

# Continental Shelf

**Because continental shelves are the nearest to land and often the shallowest parts of the ocean, they are the area of the ocean that oceanographers know the most about.**

**1** **The continental shelf is a relatively flat stretch of land off the coasts of continents.**


COAST OF SPAIN
U.S. NORTH ATLANTIC COAST
WEST COAST OF SO. AMERICA
SHELF
SHELF
SHELF
TRENCH NEAR PERU AND CHILE 46.5 MILES (75 km)
DEPTH OF OCEAN 1815 FT (550 m)
DEPTH OF OCEAN 2640 FT (800 m)
DEPTH OF OCEAN 1980 FT (600 m)
ARCTIC COAST OF RUSSIA
SHELF
DEPTH OF OCEAN 1881 FT (570 m)

© Y. Tabarés

The continental shelf slopes gradually away from land and toward the deeper part of the ocean. Each continental shelf is slightly different.

The part of the ocean floor that surrounds each continent is called the continental shelf. The width of the continental shelf can range from 40 to 60 miles (65-100 km). Those in the Atlantic Ocean tend to be larger than those in the Pacific. Though the water above the continental shelf can be almost 200 feet (60m) deep, it's fairly shallow compared to ocean depths farther from land.

The continental shelf is one of the busiest regions of the ocean. It's full of fish, animals, and plants. It's also where most offshore oil drilling is done.

**Shelf Life**

The floor of the continental shelf is sandy or muddy, with a few rocky areas dotted over the surface. Atlantic shelves tend to be calm, but Pacific shelves are often subject to earthquakes and other subterranean activity.

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# Which is older, Earth's surface or the sea floor?

OCEANS AND SEAS

1 Earth's surface

2 Sea floor

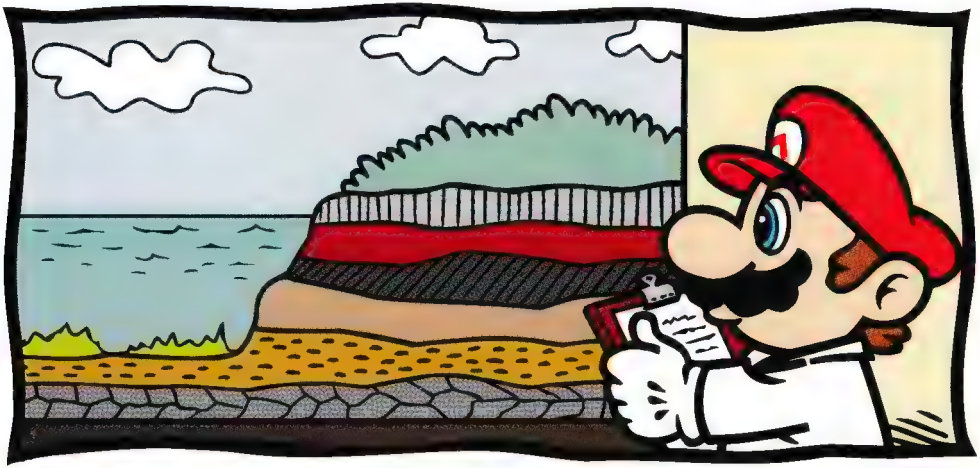


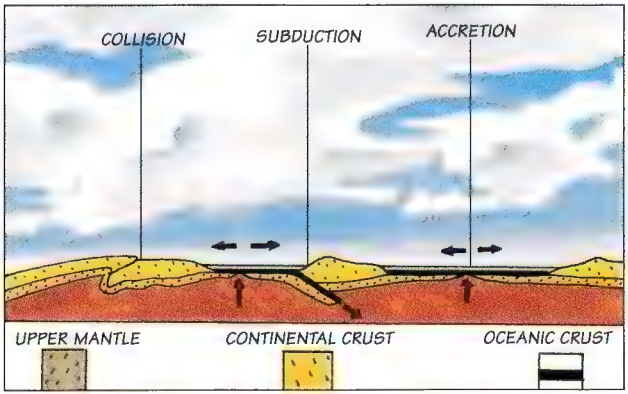
Illustration: Gary Fields

©1997 Nintendo

# Oceanic Crust

**New sea floor is produced constantly. It's made from minerals that bubble up from rifts, or cracks in the sea floor, and spread out along the bottom of the ocean.**

## 1 Earth's surface is much older than the sea floor.




When continental plates collide, they may force part of the sea floor to rise. Or one plate may slip below another. This is called subduction. Rifts between plates let new mineral deposits accumulate on the sea floor. This is called accretion.

Oceanic crust, the top layers of Earth under the sea, has three layers. The upper layer is sediment—free-floating mud and sand that moves and settles with shifts in the water. This layer is about 1,760 feet (530 m) thick. The middle layer is volcanic rock, about 1 mile (km) thick. The lower layer, about 3 miles (5 km) thick, is mineral-rich rock loaded with magnesium and iron. Throughout the world's oceans, there are cracks, called rifts, in the oceanic crust. They're formed at the sites where Earth's continental plates separated.

### Volcanic Vents

Rifts lead straight down to Earth's volcanic core and they provide an escape route for the magma, or molten rock, that rises to the surface. The magma is cooled by sea water and it turns to rock and sand that flow away from the rift and scatter across the sea floor.

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# What is a rift?

OCEANS AND SEAS

1. A large raft
2. A crack in the sea floor
3. A ship's crew member in charge of supplies

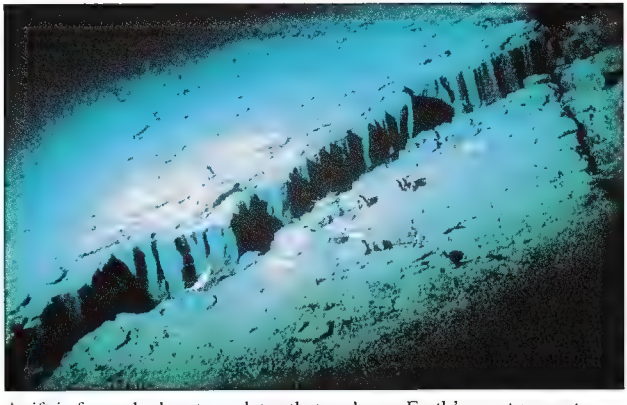
Illustration: Gary Fields

©1997 Nintendo

# Rift

**The floor of the ocean is marked with huge cracks between two of the plates making up Earth's crust. These cracks are called rifts.**

## 2 A rift is a crack in the sea floor.



© IFREMER

A rift is formed when two plates that make up Earth's crust separate.

As the plates that make up Earth's crust separate, they reveal molten rock and volcanic activity below the surface. Deep sea water is very cold, but the minerals churning below Earth's surface are hot. Cold sea water mixed with hot gases produced in the rifts create an unusual undersea environment where strange creatures survive.

**Deep Sea Worms**

Exploring these rift environments—known as vent communities because of the gases that are vented from beneath Earth's surface—oceanographers have found previously unknown species of sea creatures. Huge red worms, measuring 5 feet (1.5 m) long are anchored to the sea floor near clams that are 10 inches (25 cm) across. Many of the species of fish and crabs are blind, because the region is so dark they have no need of vision. Rifts have revealed new worlds of intriguing creatures under the sea.

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# Which word refers to conversion of ocean water to drinking water?

OCEANS AND SEAS

1 Desalination

2 Putrefaction

3 Salivation

Illustration Gary Fields

©1997 Nintendo

# Desalination

**To make ocean water safe to drink, salt and impurities must be removed from the water. This is what the process of desalination does.**

## 1 Desalination is the conversion of ocean water to drinking water.

© Len Sirman

Most of the world's desalination plants are in the Middle East, a dry region with few available freshwater resources.

In the desert nations of the Middle East, where there is little rainfall and little available fresh water, desalination is used to convert sea water to drinking water. The process is also commonly used in small island nations, such as the Caribbean island of Aruba, where sea water is plentiful but fresh water isn't. Recently, desalination has also been used in California, where the available fresh water supply is too small to serve the fast-growing population.

**Hold the Salt**

There are two basic processes used for desalination. The sea water may be boiled to separate the water from the salt. The water is then collected as steam and cooled back to its liquid state. Or the water may be strained through very fine membranes which hold the salt on one side as they let the pure water flow through.

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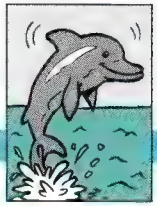
# How do oceanographers measure ocean currents?



OCEANS AND SEAS

1. With current meters
2. With aerial photos
3. With satellites

Illustration Gary Fields

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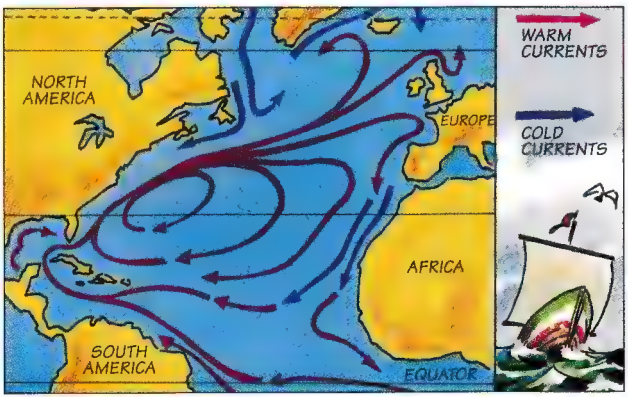
# Ocean Currents

**A simple means of measuring ocean currents is setting a float adrift. The movement of the float indicates the direction of the ocean currents.**

## 1 Current meters are devices used to measure ocean currents.




Currents of the Atlantic Ocean.

Another method for measuring ocean currents is called a current meter. This device uses a propeller which is fixed to a meter and anchored in the water. As the current flows through the propeller, it causes the propeller to turn. The meter measures the speed at which the propeller turns and this indicates the speed at which the current flows. Some of these meters are also equipped with thermometers to record the temperature of the water.

**Acoustic Measurement**

Oceanographers are now developing more precise and immediate ways to measure ocean currents. Using acoustic, or sound, waves and computer imaging, they hope to be able to make real-time maps of current movement. These maps would be useful to fishermen and sailors, and they would also help in rescue missions and the cleanup of oil spills.

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# Which is used to clean up oil spills at sea?

OCEANS AND SEAS

1. Bacteria
2. Skimmers
3. Both

Illustration: Gary Fields

©1997 Nintendo

# Oil Spills

**Cleaning up an oil spill is expensive. More than $2 billion has been spent to clean up the Exxon Valdez spill, which occurred in Alaska several years ago.**

## 3 Both skimmers and bacteria help clean up oil spills at sea.

© Len Sirman

If the spill reaches the shore, the oil-soaked sand must be removed. If the oil is left in the sand, it will kill all the plants and animals living in and around the beach.

Oil spills at sea are usually accidental. An oil tanker may suffer a collision that punctures a holding tank, or a storm at sea can cause an offshore oil rig to leak. When oil spills, it must be cleaned up as quickly as possible. The longer it remains in the water, the more damage it can do.

**Round it Up**

Oil is lighter than water, so it floats. That means cleanup crews can see where the oil is. The first step in cleanup is to contain the spill so it doesn't spread or travel. This is done by surrounding the spill with barriers called booms. Then the oil is skimmed off the surface of the water. As much as possible is reused.

**Soak it Up**

The rest is soaked up with absorbent materials such as sponges. Certain bacteria that occur naturally in sea water will eat up some of the remaining oil.

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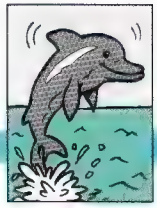
# Do oceans influence climate?



OCEANS AND SEAS

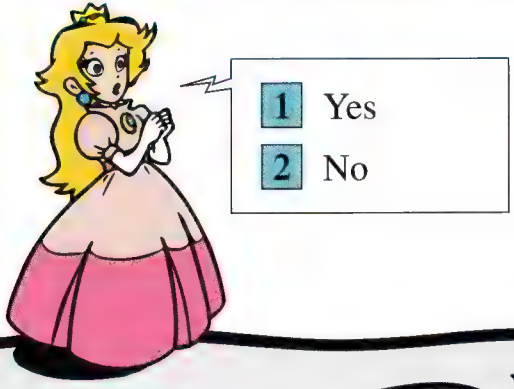


Illustration: Gary Fields

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# Oceans and Climate

**Coastal regions have different climates from inland regions at the same latitude. The temperature of the ocean water affects the temperature on the coastal land.**

## 1 Yes, oceans influence climate.

© Ptisson / Explorer

Winters in coastal areas tend to be wet but relatively warm compared to temperatures in inland regions at the same latitude.

It takes a long time for the ocean to warm up during the summer. This prolonged chill keeps air temperatures cooler at the shore than in inland areas. Similarly, once the sea is warm it takes a long time for it to become cold. This means that winters at the shore tend to be slightly milder than inland winters.

**Current Temperatures**

Ocean currents also influence air temperature. Among the best known warm ocean currents is the Gulf Stream, which flows from the Caribbean into the North Atlantic in western Europe. The Gulf Stream keeps winters mild in northwestern Europe. Recently researchers have discovered unidentified "blobs" of warm or cold water that drift around the North Atlantic. Though they're not sure what causes these giant masses, they believe that the blobs might affect weather in the eastern U.S. and western Europe.

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# Who developed the first scuba gear?

OCEANS AND SEAS

1. Jacques Cousteau
2. Thomas Edison
3. Benjamin Franklin

Illustration: Gary Fields

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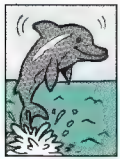
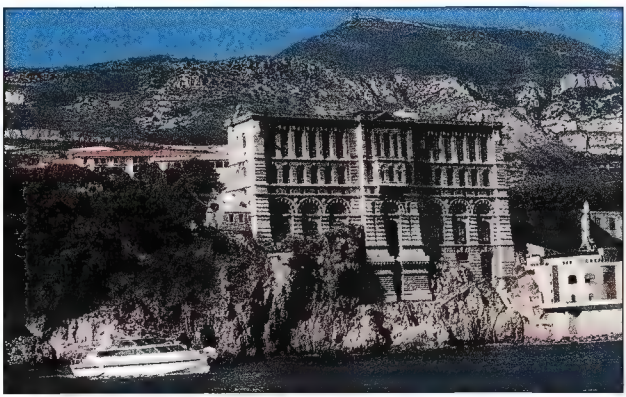
## Jacques Cousteau

**In 1943, Cousteau and engineer Emile Gagnon developed the first apparatus that allowed humans to breathe underwater. They named it the "aqualung."**

**1 French oceanographer Jacques Cousteau developed the first scuba gear.**





© E. Chmo / Explorer

Jacques Cousteau's documentary films and television series have won Academy Awards and Emmy awards. In 1957, Cousteau became director of the Oceanographic Museum of Monaco, shown here. His nonprofit Cousteau Society protects the ocean environment.

The modern version of the device is called scuba, or "self-contained underwater breathing apparatus."

From the time he was a boy, Cousteau (1910- ) was fascinated by the sea. After high school, he attended the French Naval Academy, and served as an officer in the French Navy during World War II.

Combining his interest in undersea exploration with his military duties, Cousteau made his first notes about the aqualung. When he and Gagnon finally perfected it, the device was used by French naval divers to find and disarm underwater mines after the war.

After the war, Cousteau bought a ship to use for undersea research. He called it the *Calypso*. The work of Cousteau and his crew, from the 1950s to the present, has educated and enlightened the world about the undersea environment.

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# Which is an offshore strip of rocks, sand, or coral?

OCEANS AND SEAS

1. Reed
2. Reef
3. Rig

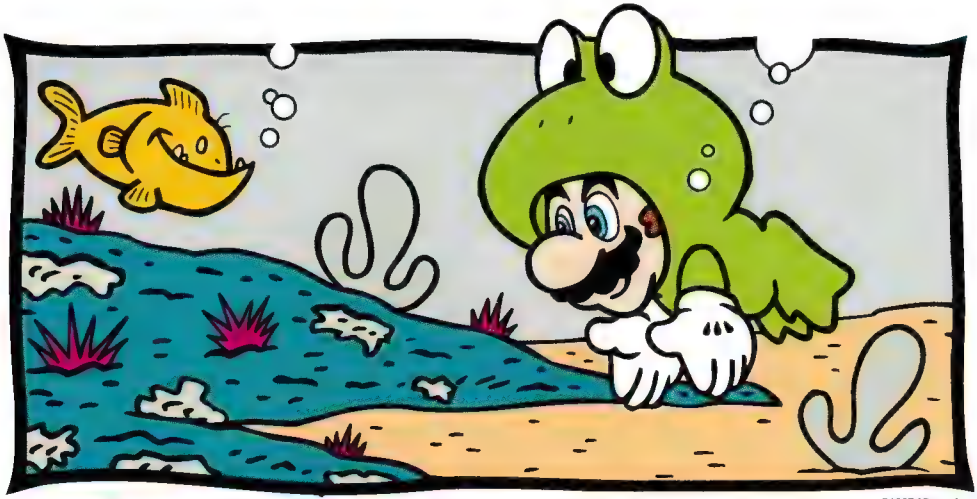

Illustration: Gary Fields

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# Reef

**Though reefs may protrude above the surface of the ocean, most of the ridge is located below the surface. Reefs can be treacherous for boaters, but they hold an allure for snorkelers and scuba divers.**

## 2 A reef is an offshore strip of rocks, sand, or coral.

© Len Sirman

Some reefs are visible from the surface of the water, others are hidden beneath the waves.

Running aground on a reef can damage or destroy a boat. Boaters are always careful to avoid coastal areas where reefs are located.

**Undersea Environment**

Divers, on the other hand, seek out reefs because of the many sea creatures that live in and around them. Coral reefs are formed from the skeletons of sea creatures called coral. Coral live in warm waters—the Caribbean and South Pacific are known for their coral reefs—and they are extremely sensitive to chemical and temperature changes. Pollution or unusual weather conditions can kill the coral and wipe out the reef.

When the reef is healthy, it attracts dozens of species of brightly colored fish. Reefs are also populated by echinoderms—spiny-skinned creatures such as starfish and sea urchins.

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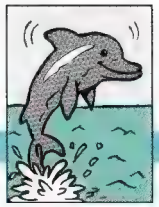
# What are the doldrums?



OCEANS AND SEAS

1. Hallucinations experienced by divers
2. Rough ocean currents
3. Windless areas near the equator

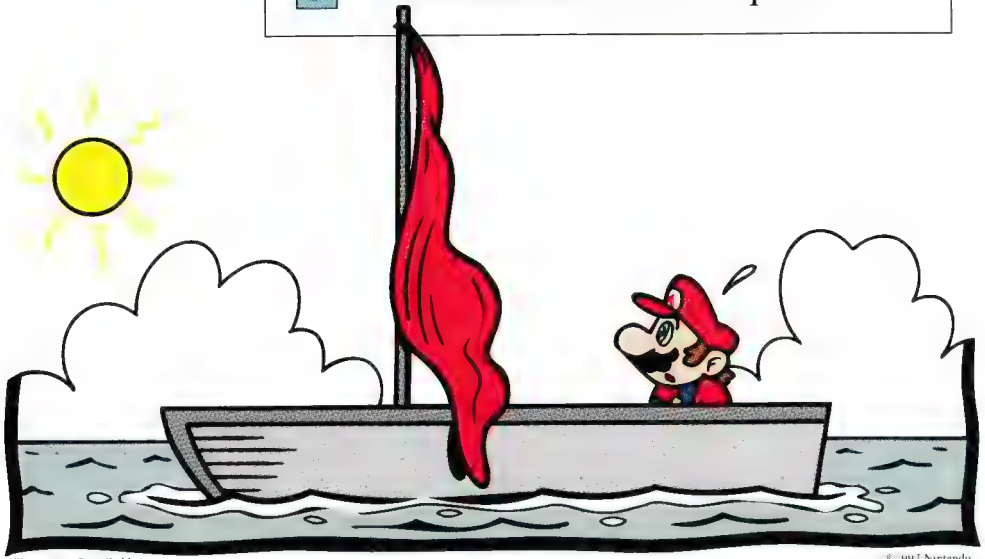


Illustration Gary Fields

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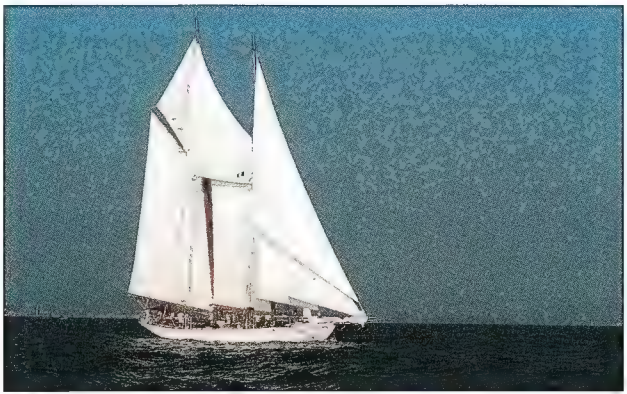
## Winds

**Steady breezes, called trade winds, blow in the regions immediately north and south of the equator. Sailors love the dependable trade winds, they mean there's smooth sailing ahead.**

# 3 The doldrums are windless areas near the equator.



© Frehaux / Sunset

When people are bored, they sometimes say that they're "in the doldrums." The expression comes from the region at the equator, where the wind doesn't blow and nothing much happens.

Trade winds south of the equator blow north and those north of the equator blow south. The point where the two trade winds meet—almost directly on the equator—is called the doldrums. In this band of latitude there's virtually no wind at all!

**Hard Sailing**

If you travel away from the equator, past the bands of trade winds, you reach another windless region known as the horse latitudes. They earned their name because ships transporting horses from Spain to the New World were often stuck in these windless areas for so long that the horses died. The sailors threw them overboard, and the waters of the horse latitudes became littered with horse carcasses.

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# What is oceanography?

OCEANS AND SEAS

1. Conservation of the ocean environment
2. Saltwater sport fishing
3. Scientific study of oceans

Illustration Gary Fields

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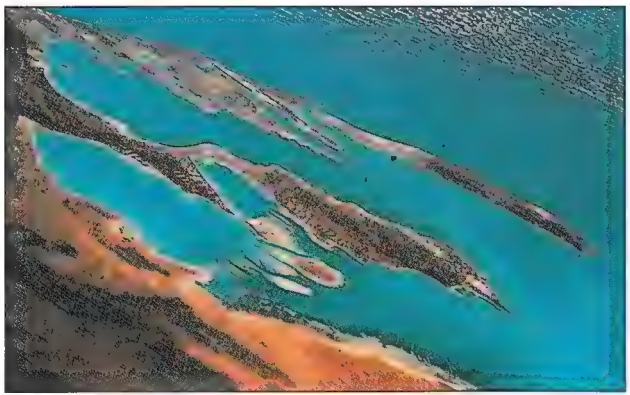
# Oceanography

**About 71 percent of Earth's surface is covered by oceans. No wonder scientists devote their lives to studying them!**

## 3 Oceanography is the scientific study of oceans.



© Saluber / Liaison / Gamma

Satellite photos are among the many information resources used by oceanographers.

Oceanography is the scientific study of every aspect of oceans—physical shapes, structure of the ocean floor, temperature and mineral content of the water, and plants and animals living in and around the water.

### Sea Specialists

Most oceanographers specialize in one particular aspect of the science. Marine geologists, for example, study the rocks and physical features of the ocean floor. Marine biologists are mainly concerned with aquatic plants and animals.

### Voyage of Discovery

The science of oceanography developed in the 19th century, when the sea was a primary means of travel and trade and there was a need to know as much as possible about it. The first true oceanographic expedition was the voyage of the *HMS Challenger* in 1872. This research ship traveled around the world solely for the purpose of studying the ocean.

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# What does the Minerals Management Service oversee?

OCEANS AND SEAS

1. Offshore drilling
2. Prevention of beach erosion
3. Protection of coral reefs

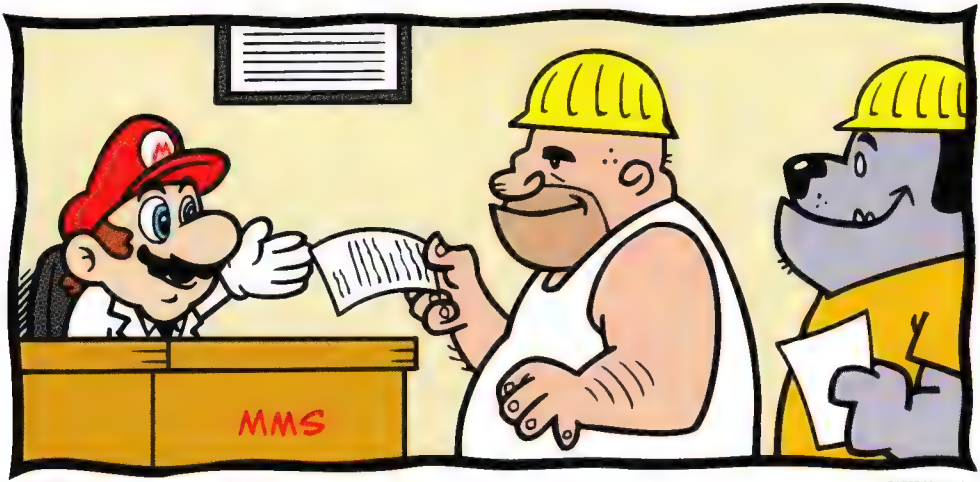


Illustration Gary Fields

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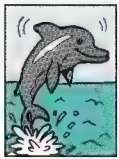
# Offshore Drilling

**The Minerals Management Service, or MMS, is a United States government agency. It's part of the Department of the Interior.**

## 1 The Minerals Management Service oversees offshore drilling.



© Gamma

Minerals Management Service issues permits for companies to drill or mine beneath the sea floor. MMS also conducts health and safety inspections on offshore oil rigs.

The Minerals Management Service establishes rules and policies for offshore drilling and mining in underwater regions surrounding the United States.

### What's Down There?

Beneath the ocean floor are reserves of petroleum, or oil, and natural gas. There are also deposits of minerals, such as manganese, gold, and phosphorite. About 17 percent of U.S. oil reserves and 25 percent of natural gas reserves are located underwater. Extracting these natural resources can be beneficial, but drilling and mining must be done in a controlled way so that the resources are not destroyed or completely depleted. So, MMS permits drilling only in designated areas.

### Outer Continental Shelf

In general, coastal waters near land are controlled by the states. MMS regulates waters that are at least three miles from land. This region is known as the Outer Continental Shelf.

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# Do volcanic eruptions occur underwater?

OCEANS AND SEAS

1 Yes

2 No

Illustration: Gary Fields

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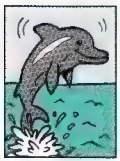
# Volcanoes

**Many of Earth's volcanoes are located underwater, especially in regions known as mid-ocean ridges. These are the places where Earth's tectonic plates are separating.**

## 1 Yes, volcanic eruptions occur underwater.



© Lecois / Liaison / Gamma

Lava from underwater volcanoes sometimes reaches the water's surface.

Mauna Loa, the biggest volcano in Hawaii, originates underwater. It's so tall—30,000 feet (9,100 m)—that it rises far above the surface of the ocean. Other underwater volcanoes are much smaller.

**Ooze in the Ocean**

Volcanoes erupt when the magma, or molten rock, inside Earth bubbles up and out of a crack in Earth's surface. Once the magma emerges, it's called lava.

Lava can burst out of Earth's surface below the sea, too. When it does, the ocean water cools it quickly, and this produces some weird effects. When the molten lava meets the cold water, the lava cracks, like ice cubes do when they're dropped into a glass of lukewarm water. More lava seeps through the cracks and then it too cools and cracks. This underwater lava creates rock formations with ripples and rounded edges like pillows.

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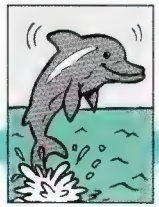
# What is benthos?



OCEANS AND SEAS

1. Frequency of ocean waves
2. Organisms living on the sea floor
3. Scientific name for high tide

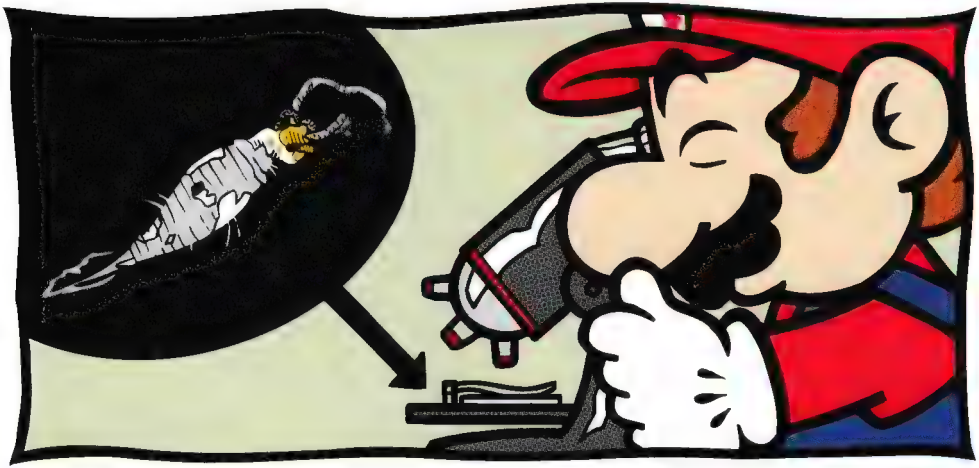


Illustration: Gary Fields

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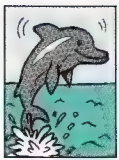
# Benthos

**The collection of tiny organisms that live on or near the sea floor are known as benthos. They include both plant and animal organisms.**

## 2 Benthos is organisms living on the sea floor.



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Benthic organisms live on or near the sea floor. The largest of the group grow to be just 0.04 inch (1 mm) in size.

Benthic organisms range in size from tiny to microscopic. The largest of the group, known as macrobenthos, are about 0.04 inch (1 mm) long. That's about as big as a grain of sand! Macrobenthos includes various types of worms, sponges, echinoderms (spiny-skinned creatures) and crustaceans.

Meiobenthos are slightly smaller than macrobenthos. They are between 0.1 mm and 1 mm in size.

And microbenthos are the tiniest of benthic organisms. They grow to be less than 0.1 mm in size, and include single-celled organisms such as amoeba and bacteria. Benthic organisms crawl or burrow. They may also attach to rocks and other formations on the sea floor.

### Eat or Be Eaten

Benthic organisms feed on plankton and organic debris in the water. They are a food sources for fish, starfish, snails, and some crustaceans.

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# How are lobsters caught?

OCEANS AND SEAS

1. In nets
2. In traps
3. On fishing lines

Illustration: Gary Fields

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# Lobsters

**Typical lobster traps are called box traps. Lobsters crawl into them, but they can't crawl out.**

## 2 Lobsters are caught in traps.

© Animals Animals / Sunset

Most lobster traps are made of wood. Inside is a synthetic net bag that holds the bait and traps the lobster.

The large "true" lobsters that people eat are known as American lobsters. They are found in cool waters off the coast of eastern North America, from Virginia to Canada. A different type of small lobster, called the spiny lobster, is found in warmer waters throughout the world, including California and the Caribbean.

Lobsters are known for their powerful claws, which are two different sizes and shapes. The smaller, narrower claw is used to cut dead fish. The larger claw crushes shells and other hard objects.

### Tasty Traps

Lobster traps are baited with dead fish—a lobster's favorite food. As the lobster makes its way toward the bait it becomes trapped and it can't escape. A lobster fisherman's biggest obstacle are seals who raid the traps and steal the bait before it lures the lobsters into the trap.

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# Can people live and work underwater?

OCEANS AND SEAS

1 Yes

2 No

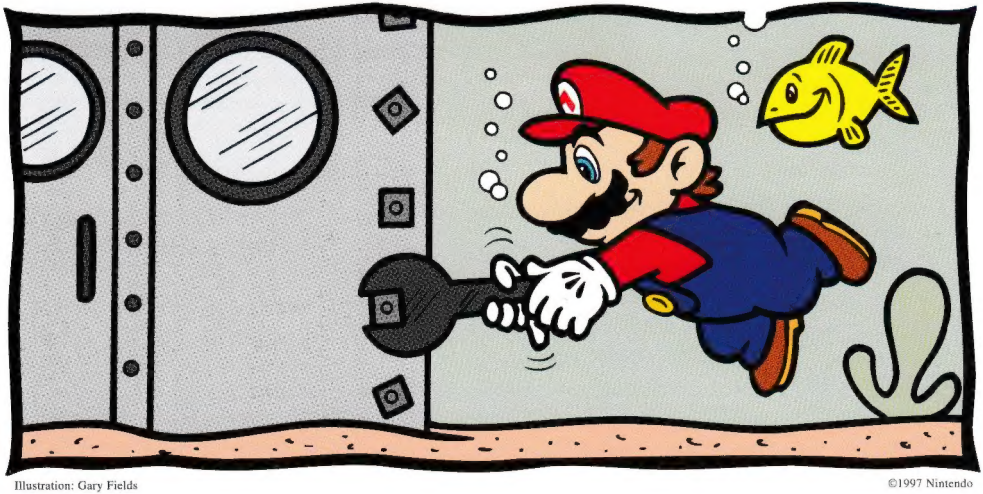

Illustration: Gary Fields

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# Underwater Research

**The National Oceanic and Atmospheric Administration, also known as NOAA, operates underwater research facilities where scientists live and work.**

## 1 Yes, people can live and work underwater.

© Len Sirman

Commercial divers are employed by business and industry to do inspections and repairs on underwater structures such as bridges, piers, oil rigs, pipes, and cables.

Underwater research is conducted for many reasons. Biologists and zoologists study aquatic plants and animals. Geologists study the composition of the ocean floor and dig beneath it to uncover minerals and natural resources.

### Home Beneath the Sea

In 1972, NOAA inaugurated its first underwater research facility, *Hydrolab*. This undersea habitat was based in the Caribbean, In its 13 year history more than 600 researchers from 9 countries lived and worked there. *Hydrolab* was taken out of service and is now on display at the Smithsonian Institution in Washington, DC. It was replaced by an upgraded facility called *Aquarius*.

### Diving Pros

Professional divers may do scientific research or they may be employed by businesses. They also participate in rescue and recovery missions for police and law enforcement agencies.

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